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ABSTRACT

This guide focuses on the conservation plan for an outdoor laboratory. Although the plan focuses specifically on Seaman Outdoor Education Laboratory, the concepts could be applied to any natural area including parks, farms, and school grounds. Along with an introduction and justification, the guide includes the conservation plan that serves as the blueprint for the use and treatment of the land to be used; it was developed on the basis of intended land use. The conservation plan includes the plan map and a general overview of the area. A natural resources inventory that looks at the soils, the geology, the grassland, woodland, and the biology of the area is presented. Also included are environmental projects such as field trips, nature trails, activities, ideas, worksheets, and a teacher's planning guide, and a bibliography. (TK)

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Kansas University
State Geological Survey
State Biological Survey

Kansas Department of Education

State Soil Conservation Committee

Kansas State University
District Extension Forester

Lyman Elementary School

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FOREWORD

The education of the general public, the teacher, the student, both young or old, and urban or rural is of great importance if our nation is to survive and continue to enjoy the environment that has been so casually taken for granted through the years.

In support of this belief the Board of Supervisors of the Jefferson County Soil Conservation District extended their full support to Seaman High School District Number 345 when approached for assistance in developing an Outdoor Laboratory.

The Board asked for and received cooperative assistance from the U. S. Department of Agriculture Soil Conservation Service, Kansas State University, and the State Geological Survey and the State Biological Survey of Kansas University.

It is our hope that the plan will contribute to a better understanding and appreciation of the natural and environmental resources of rural America.

Paul W Hensleigh
Paul Hensleigh, Chairman

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John Hamon, Member

INTRODUCTION

Inception of the Program

A planning grant was received from the U. S. Department of Health, Education and Welfare during the period from October to December 1966. The planning grant enabled personnel of the district to visit existing programs throughout the country. Knowledge acquired from the actual inspection of active programs broadened our concept of the potentials derived from this type of curriculum enrichment. Some aspects of those programs visited were not applicable to our program whereas other aspects were not deemed desirable for our project. The planning grant more deeply entrenched our desires to integrate an outdoor education curriculum into the present curriculum in the school district. We realized some of the community resources such as park districts, YMCA camps, etc. that are many times available to assist a school in instituting a program were not available in the Seaman District.

In May 1967 a lease was signed with the U. S. Army Corps of Engineers for an outdoor education laboratory. The laboratory contains 104 acres on the Perry Reservoir near Topeka. The site is southwest of the new town of Ozawkie. It is situated on a relatively high ridge, surrounded on three sides by water impounded by the Perry Dam. Perry Reservoir at conservation level is a 12, 200 acre lake. The purpose of Perry Reservoir is threefold: flood control on the Kansas River Basin, water conservation and recreation. The laboratory has much educational and recreational potential. It is close to all schools in the district, being approximately 20 miles from Seaman High School. A 24 by 36 foot storage building has been constructed. It contains rest rooms and storage space plus shelter during inclement weather. A private road of three-fourths of a mile has been constructed into the area. The area is remote and there is an abundance of wildlife. The area previously had been cropland and pasture areas. The school anticipates developing various types of natural areas whereas other areas will not be disturbed in order for natural succession to occur. The undisturbed areas will be particularly interesting to biology classes. Various types of habitats will be developed in order to provide shelter for wildlife. Nature trails, an arboretum, native timber, a forestry

project, a windbreak, native prairie, a plot of introduced grasses, shoreline ecology, a boating dock, go-back pasture, farm pond ecology, and cropland succession are some of the potential areas for development.

The outdoor program during the regular school term provided assistance to individual teachers in working with their children in the out-of-doors. Teachers may acquire assistance by contacting their principal who will in turn contact the outdoor staff. The outdoor staff and teacher then plan the activity that will be carried out with the outdoor staff's assistance. The outdoor staff arranges transportation and other details necessary for the successful completion of the activity. The classroom teachers are responsible for preparing the children for the trip and the follow-up activities in the classroom. This assistance is available to all teachers in the district from kindergarten through twelfth grade and in any area of curriculum.

Although this plan is specifically for the Seaman Outdoor Education Laboratory, the concepts could be applied to any natural area including parks, farms, school grounds, etc. It is sincerely hoped that this plan will contribute to the development of other laboratories through the cooperation of concerned individuals and agencies. This type of cooperation is essential if meaningful environmental education programs are to evolve.

In the words of Lloyd Sharp, "Those things which best could be learned indoors should there be taught, but those things which best could be learned in the outdoors, using native materials and real life situations, should there be taught."

Objectives of the Project:

1. Provide opportunities and facilities for educationally sound field trips, hikes, journeys, etc.

2. Give impetus to school gardening plans at the school and at the outdoor facility.

3. Provide some farming experience, or, at a minimum, to insure visits to a farm.

4. Provide professionally qualified personnel in the field of outdoor education to work with teachers and students in the varied subject and activity areas.

5. Develop an awareness of the importance of conserving our natural resources which provide us with food, clothing and shelter.

6. Grasp scientific understanding by seeing features of nature in their natural setting.

7. Develop an awareness that all things in nature constantly change.

8. Promote an understanding of the interdependence of various facets of nature.

9. Give students an opportunity to share knowledge and experience with classmates.

10. Encourage good health practice.

11. Develop individual skills for leisure time activities.

12. Develop self-reliance as well as cooperation.

13. Recognize the values of an informal group-living experience.

14. Develop an awareness, appreciation, and affection for nature by emphasizing that the purpose of resource management is to benefit people.

15. Develop a competency and respect among the teaching staff for the values of outdoor education and recreation.

16. Involve the adult community in the skills and benefits of outdoor recreation and education.

17. Achieve the following objectives in relation to their specific subject areas:

    A. Arithmetic

        1) Use standard instruments and measures (compass, ruler, tape, plumb line, gallon, etc.)

        2) Apply arithmetic to everyday living.

3) Develop pupils' ability to estimate (distance, time, quantity, etc.).

4) Supply arithmetic skills to outdoor first-hand experience.

5) Involve students in use of math skills in maintenance and construction of camp.

B. Social Studies

1) Create interest in and understanding of local history.

2) Develop an understanding of democratic procedures and group processes.

3) Create understanding of the relationship between man and his environment.

4) Develop understanding of some of the social-emotional needs of man.

5) Develop understanding of how local government functions.

6) Develop an understanding of the value of resources.

C. Language Arts

1) Write legibly and spell correctly.

2) Express self well in both written and spoken word.

3) Read and interpret correctly.

4) Enrich vocabulary and concepts.

5) Learn how to gesture and how to detect misconceptions.

D. Life Sciences

1) Recognize plants and animals and natural communities.

2) Understand interrelationships of plant and animal life in different environments (habitats) of the local area.

3) Know various methods of seed dissemination.

4) Know uses for different plants and animals.

5) Understand the need for conservation of plant and animal life.

6) Observe first-hand weather and seasonal changes.

E. Earth Sciences and Astronomy

1) Understand general characteristics of rock strata in local areas as they relate to plant, animal, water and human use.

2) Understand history of rock and soil formulation.

3) Study relationship of surface terrain to underlying rock strata.

4) Understand causes, effects, and ways to control erosion and soil fertilization.

5) Recognize major constellations and their relationship to the earth's motion.

6) Understand forces in weather events.

F. Health and Physical Education

1) Develop wholesome mental attitudes and habits.

2) Practice good health habits and safety practices.

3) Plan and practice good use of leisure time.

4) Keep physically fit.

5) Develop awareness of survival and comfort practices in the outdoors.

6) Develop working knowledge of first-aid.

G. Arts and Crafts, Music, and Drama

1) Explore a variety of media with emphasis on natural materials.

2) Encourage imaginative as well as realistic ideas.

3) Consider art and music as part of everyday living.

4) Develop handiness with common tools.

5) Get everyone involved in activities such as skits or singing to promote fun.

6) Get students involved in decoration and maintenance.

VALUE OF FARM AND RANCH CONSERVATION PLANNING

The prosperity and survival of the United States depends in large measure on how fast owners and operators of land carry out a planned program of use of their land within its capabilities and treatment according to its needs.

A conservation plan is a blueprint for use and treatment of a unit of land. Here are some of the reasons that make the conservation plan so vital:

1. The conservation plan is the framework upon which the entire conservation program is built. Through excellent installation and diligent practice of the plan, the agricultural resources will be safeguarded, pollution markedly reduced, and the physical environment greatly enhanced.

2. It presents a true inventory of the resources at hand and the conservation measures needed.

3. It provides a schedule for progressively carrying out the needed soil, water, and plant conservation measures so that they compliment each other in achieving total conservation.

4. It is a guide to insure the proper use of each acre of agricultural land.

5. It makes possible the planning of water management systems, as drainage, surface runoff which involves more than one farm or ranch, and makes possible the most efficient use of available water supplies.

6. It provides information for determining costs of new or improved practices and the effects or benefits of these practices.

7. It serves as a basis upon which to establish agricultural credits

8. It provides a means of establishing the proper combination of enterprises balancing the available resources, manpower, and capital investment against the requirements for crop and livestock production.

9. It lays a foundation for the work of all cooperating agencies that may help the Soil Conservation district and the farmers or ranchers to do the conservation job.

10. It serves as a basis for determining the workload within the district so that need for technical and other assistance can be readily determined. It insures efficient use of time by technicians, the farmer, and the soil conservation district.

THE CONSERVATION PLAN

A conservation plan is developed on the basis of intended land use. Such factors as soils, geology, vegetation, wildlife, woodland, climate and the landowner's intent are considered when a permanent land use is chosen. More often than not, a field with a given land use will have alternative choices and the decision then is made by the landowner or operator.

The normal or typical conservation plan is developed to present a timely action program that will enhance the value of the land, increase productivity and stabilize or decrease the erosion hazard.

> The Seaman Outdoor Laboratory Conservation Plan will differ from the normal in that it will attempt to stabilize present conditions which exist. To apply the normal plan over a period of years would tend to reduce teaching values that exist in all the various land uses.

Major land uses are as follows: cropland, hayland, pastureland, rangeland, recreation, wildlife, woodland, orchard and vineyard, and other land.

Each major land use adapted to this section of the state, and its related management practices, will be presented to familiarize classes with the format of a conservation plan. Decisions and actions will be noted only on those areas where improvements or changes in existing land use are planned. The various land uses and their related conserving practices common to this area will be covered in the narrative portion of the plan. Conservation practices to be applied, demonstration plots, nature trails, plantings and other related projects will be completed as funds are available. Many of the simpler practices can be adapted to class projects or teaching demonstrations. Applying more complex practices will require technical help and hiring contractors. Assistance on a consultive basis may be obtained from the agencies contributing to the development of the plan.

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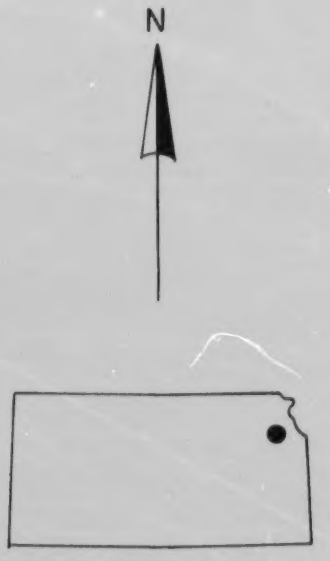
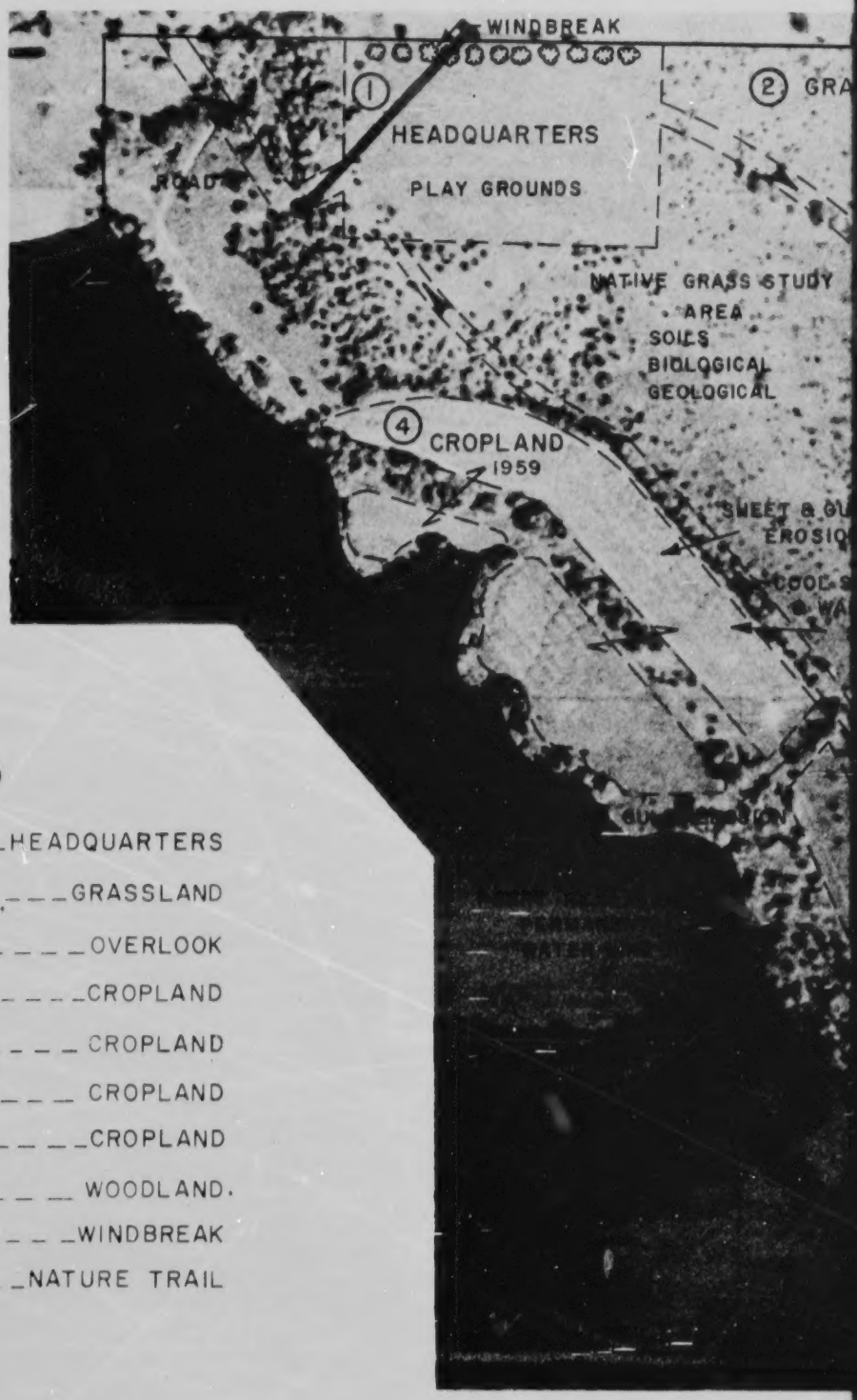
CONSERVATION PLA





LEGEND

1. HEADQUARTERS
2. GRASSLAND
3. OVERLOOK
4. CROPLAND
5. CROPLAND
6. CROPLAND
7. CROPLAND
8. WOODLAND.

WINDBREAK

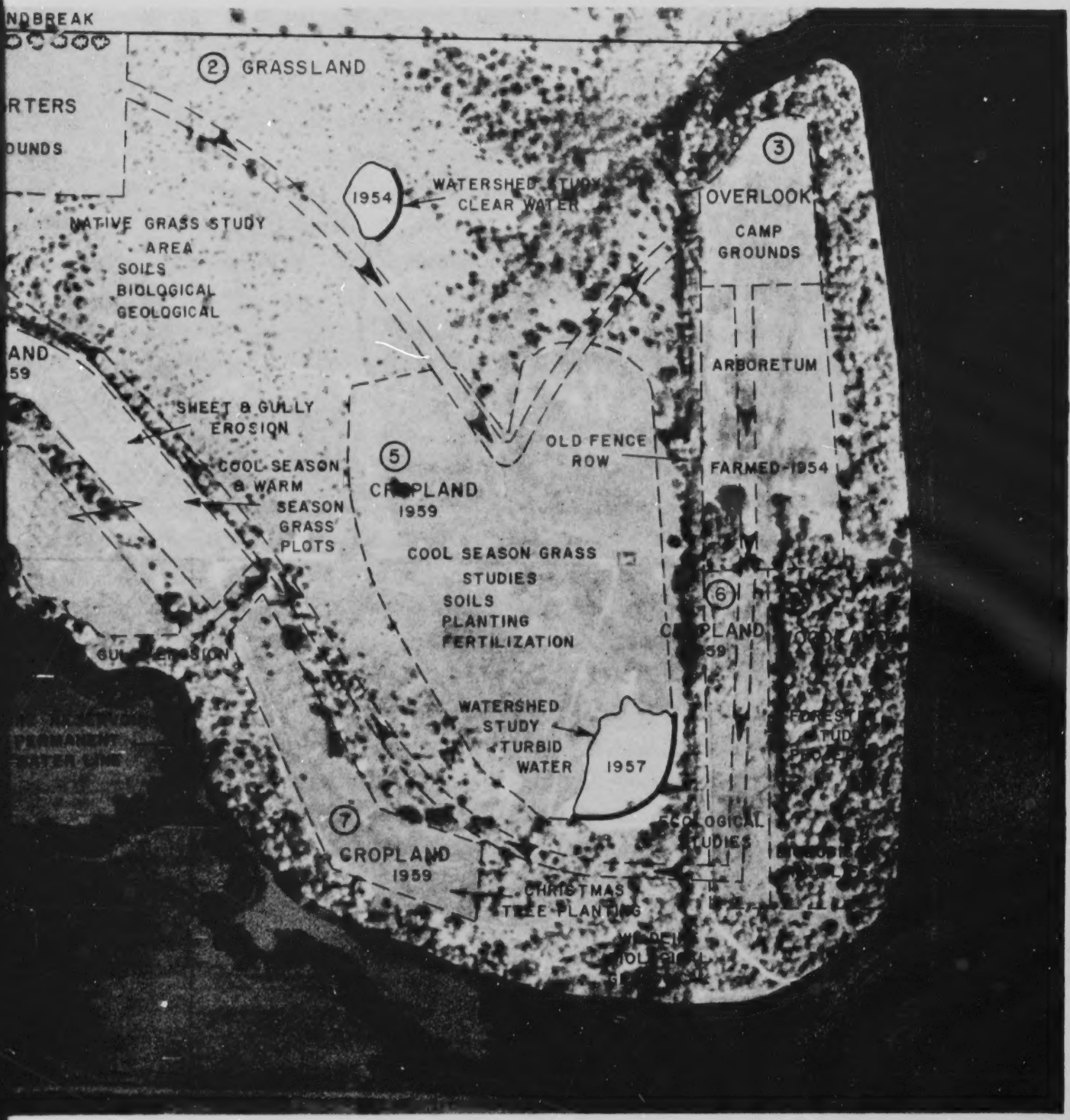
NATURE TRAIL

SCALE 660

USDA SCS-LINCOLN, NEBR. 1970

SOIL CONSERVATION SERVICE

SERVATION PLAN MAP



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APPROXIMATE

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CROPLAND

Land used primarily to produce adapted close growing field crops, fruit, or nuts for harvest, alone or with sod crops.

Fields 1, 3, 4, 5, and 6

These fields were all former cropland. All or part of these fields were farmed until 1954 to 1959. They show the effects of sheet and gully erosion. Topsoil has been lost in many places and rilling and gullying is evident on each field.

While these fields are no longer cropland, it is well to point out their past cropping history. It is also important to mention the mechanical and cultural practices normally used on a crop field if it is to remain in cultivation. As they go to and from the laboratory area, students can observe these practices.

Treatment practices for cropland fields are:

Mechanical practices:

Diversion: A channel with a supporting ridge on the lower side constructed across the slope.

Terrace: An earth embankment or a ridge and channel constructed across the slope at a suitable spacing and with an acceptable grade.

Grassed waterway: A natural or constructed waterway or outlet either shaped or graded and established in suitable vegetation as needed for the safe disposal of runoff from a field, diversion, terrace or other structure.

Drainage: A graded ditch for collecting excess water within a field.

Grade stabilization structure: A structure to stabilize the grade or to control head cutting in natural or artificial channels.

Land leveling: Reshaping the surface of land to planned grades.

Vegetative practices:

Conservation cropping system: Growing crops in combination with needed cultural and management measures. Cropping systems include the use of rotations that contain grasses and legumes, as well as sequences, in which desired benefits are achieved without the use of such crops.

Contour farming: Conducting farming operations on sloping land in such a way that plowing, land preparation, planting, and cultivation are done on the contour. This includes following established grades of terraces, diversions or contour strips.

Crop residue management: Utilizing plant residues in cultivated fields to prevent erosion and to improve the soil.

Critical area planting: Stabilizing silt-producing and severely eroded areas by establishing vegetative cover. This includes woody plants, such as trees, shrubs, or vines and adapted grasses and legumes established by seeding or sodding to provide long-term cover.

HAYLAND

Land used primarily for the production of hay from long-term stands of adapted forage plants.

Fields 2 and 5

That area of field 2 southeast of the headquarters area is presently in an excellent condition class of native grasses. In a normal farm or ranch operation this field could serve as a hayland source. Being in excellent condition and under proper hayland management, the grasses would maintain their proper climax vegetative condition.

Field 5 is seeded to cool season species which under good management will maintain good quality and quantity hay yields. See the grassland section for species of both cool season and native grasses.

PASTURELAND

Land used primarily for the production of adapted domesticated forage plants to be grazed by livestock.

Field 5

This field was farmed until approximately 1959. It was then seeded to smooth brome, a domesticated cool season grass. Cool season grasses are often used in the long-time rotation of cropland.

Under normal farming operations pasture and hayland management practices on cool season grasses are as follows:

Brush control: Killing or suppressing brush by mechanical, chemical, biological or other means on all areas.

Proper grazing: Grazing pastureland at an intensity which will maintain adequate cover for soil protection and maintain and improve the quality of desirable vegetation.

Fertilization: Applying adequate amounts of recommended commercial fertilizers to provide high level forage production.

Rotation grazing: Grazing under a system where one or more grazing units are rested at planned intervals throughout the grazing season of the key plants and generally no unit grazed at the same time in successive years.

Farm ponds: Designing and constructing ponds at intervals or locations which will help distribute the grazing pattern of livestock.

Salting stations: Designing and constructing salt stations at intervals or locations which will help distribute the grazing pattern of livestock.

A small portion of this field will be used to demonstrate the results of the above management practices. The remainder of the field is to serve as a check compared to treated area.

RANGELAND

Land used primarily for the production of adapted forage plants (primarily native plants) to be grazed by livestock.

Field 2

That area southeast of the headquarters area is presently in an excellent condition class of native grasses. In a normal ranch operation this field would serve as a pasture. The field being in excellent condition, proper management practices would maintain the proper climax vegetative condition.

Rangeland management practices are:

Brush control: Killing or suppressing brush by mechanical, chemical, biological or other means on all areas.

Proper grazing: Grazing at an intensity which will maintain adequate cover for soil protection and maintain and improve the quality of desirable vegetation.

Farm ponds: Designing and constructing ponds at intervals or locations which will help distribute the grazing pattern of livestock.

Salt stations: Designing and constructing salt stations at intervals or locations which will help distribute the grazing pattern of livestock.

A small portion of this field will be used to demonstrate the results of the above management practices. The remainder is to serve as a check compared to the treated areas.

Cool season and native grass plots will be established in field 4 about as shown on the Grassland map. Refer to the Grassland section for information on species and establishment.

RECREATION

Land and water used primarily for facilities essential to recreational use.

Fields 1 and 3

Recreational area improvement: These fields will be developed for headquarters, parking, camp grounds, playgrounds and overlooks. Traffic will present a problem on the vegetated areas. Main trafficways and walks will be designed on the contour as feasible and should eventually be surfaced with gravel or other suitable material.

Playground areas, after shaping, will be seeded, to cool season grasses. Fescue will be seeded at the rate of seven pounds per thousand square feet. Area will be mowed and fertilized annually to maintain vegetative growth.

Recreation trail and walkway: A recreation trail or nature trail will be established about as shown on the conservation plan map. The trail will be constructed to minimize erosion hazards. The steeper sections may need steps which could become class projects. Branch trails will be added as each of the demonstration sites are developed. (See project section for specific ideas on nature trails.)

WILDLIFE

Land and water planned and managed primarily for use by fish and wildlife.

Fields 1, 2, 3, 4, 5, 6, 7, and 8

These fields will be used for study of wildlife. For comparative purposes, some will be managed to control the vegetative cover whereas others will be left for observation of natural plant and animal succession in the absence of management. See the biology section for lists of species expected and suggestions for study.

The normal management practices related to wildlife areas are as follows:

Wildlife watering facility: Constructing, improving, or modifying watering facilities for wildlife.

Wildlife wetland management: Retaining, creating, or managing a wetland habitat for wildlife.

Wildlife habitat management: Retaining, establishing, or managing wildlife habitat other than wetland.

WOODLAND

Land used primarily for the production of adapted wood crops or to provide tree cover for watershed protection.

Fields 3, 4, 6, 7, and 8

These fields encompass the wooded portion of the outdoor laboratory. It will be used for the production of timber and wildlife habitat. The area also lends itself well to recreational use. The fields will also serve to demonstrate woodland management practices.

An arboretum will be established in field 3 about as shown on the woodland map. A Christmas tree planting will be established in field 7. Refer to the woodland section for information on resources, species, establishment and management of both projects.

Woodland management practices are as follows:

Woodland improved harvesting: Removing merchantable trees from woodland.

Woodland improvement: Improving woodland by thinning, pruning, weeding, and other cultural methods.

Woodland site preparation: Treating open areas or understocked woodland areas to encourage natural seeding of desirable trees or to permit reforestation by planting or direct seeding.

OTHER LAND

Land used for purposes not covered above. This will include roads, parking areas, and buildings.

Field 1

At the present time no special conservation practices are planned for these fields. As construction progresses, special attention

will need to be given to controlling runoff from the buildings and parking areas. Roadside erosion will also need to be considered as steep unstable grades will be encountered on access roads.

SOILS

The soils occurring on the outdoor laboratory formed in material weathered from rocks of the Pennsylvanian Age and deposits of the Pleistocene Age.

Soil is produced by the action of soil forming processes on material deposited or altered by geologic forces. The characteristics of the soil are determined by:

1. The physical and mineralogical composition of the parent material.

2. The climate under which the soil material has accumulated and existed since accumulation.

3. The plant and animal life on and in the soil.

4. The relief or lay of the land.

5. The length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material accumulated through the weathering of rocks and slowly change it into a natural body having genetically related horizons.

The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of soil profile that is formed.

Time is needed to change the parent material into a soil profile. It may be much or little but some time is always required to develop a soil horizon. Soils are classified according to their significant characteristics. Soil classification information includes the relationship of one soil to another and to the whole environment, and principles to help understand their behavior and their response to man. Through classification and the use of soils maps, knowledge of soils is applied to specific fields or other tracts of land.

Soil scientists make a survey to learn the kinds of soils in an area, where they are located, and how they can be used. As they travel over the area, they observe steepness, length, and shape of slopes; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dig many holes to expose soil profiles. A profile is the sequence of natural layers or horizons in a soil; it extends from the surface down into the parent material that has been little changed by leaching or action of plant roots.

Soil scientists make comparisons among the profiles they study. They compare these profiles with those in areas nearby and in places more distant. They classify and name soils according to uniform nationwide procedures. The soil series and the soil phase are the categories most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important traits. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Elmont and Reading, for example, are the names of two soil series.

All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural landscape.

Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of the soil phase indicates a feature that affects management. For example, Elmont silt loam, 4 to 7 percent slopes, is one of several phases within the Elmont series.

After a guide for classifying and naming the soils is worked out, the soil scientists draw boundaries of the individual soils on aerial photographs. These photographs show woodland, buildings, field borders, trees, and other details that greatly help in drawing soil boundaries accurately. The soil map of this area is prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management

of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series or of different phases within one series. A soil complex consists of two or more soils so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of two or more dominant soils; the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Sogn-Vinland complex is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey. But they are called land types instead of soils and are given descriptive names. Alluvial land and stony steep land are examples of land types.

U. S. DEPARTMENT OF AGRICULTURE

SOIL AND CAPABILIT

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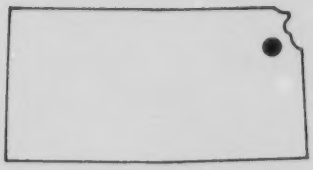

LOCATION IN KANSAS

SCALE 660

USDA SCS LINCOLN, NEBR. 1970

SOIL CONSERVATION SERVICE

L AND CAPABILITY MAP

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APPROXIMATE

11-3-70

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TABLE

Soils on the Outdoor Laboratory

Land Classified by Land Capability Classes

Soil Map Symbol	Soil Name*	Land Capability
2	Alluvial Land	VI
M2C	Elmont silt loam, 4 to 7 percent slopes	III
M2D	Elmont silt loam, 7 to 12 percent slopes	IV
F5C	Martin silty clay loam, 3 to 7 percent slopes	III
F4C	Oska silty clay loam, 3 to 7 percent slopes	III
F2B	Pawnee clay loam, 1 to 3 percent slopes	II
1M2	Reading silt loam	I
5	Sogn-Vinland Complex	VI
7	Stony Steep Land	VII

* All soil names are tentative and subject to change until the Jefferson County Soil Survey is completed and final correlation of all soils in the county is made with the National System of Soil Classification.

The following is a general description of the soils that occur on the outdoor laboratory. Detailed descriptions will not be included in the plan but will be available in reference library.

Class I Soils, colored green on the soils map, have few limitations that restrict their use. They are productive and suited to cropland, grassland, woodland, wildlife land or recreation land.

IM2 Reading silt loam - This is nearly level land that occurs on stream terraces. This is a deep, dark colored, silty textured soil that formed in thick alluvial deposits.

Class II Soils, colored yellow on the soils map, have some natural condition that limits the kinds of plants they can produce or that requires some easily applied conservation practices when they are cultivated. They are suited for cropland, grassland, woodland, wildlife land, or recreation land.

F2B Pawnee clay loam, 1 to 3 percent slopes - This is gently sloping land that occurs in the uplands. This is a deep, dark colored soil that has a loamy textured surface soil that grades into a clay subsoil. It formed in glacial material and commonly contains some glacial gravel or stones on or in the soil.

Class III Soils, colored red on the soils map, have more serious limitations than those in Class II. These soils are more restricted in the crops they can produce or when cultivated, require conservation practices that are more difficult to install and maintain.

M2C Elmont silt loam, 4 to 7 percent slopes - This is moderately sloping land that occurs on uplands. It is deep, dark colored, well drained soil that formed in material weathered from shale.

F5C Martin silty clay loam, 3 to 7 percent slopes - This is moderately sloping land that occurs on uplands in association with interbedded shale and limestone. It is a deep, dark colored, well drained soil that has a silty textured surface layer that grades into a clay subsoil. It formed in material weathered from shale.

F4C Oska silty clay loam, 3 to 7 percent slopes - This is moderately sloping land that commonly occurs on uplands above and adjacent to outcrops of limestone. This is a moderately deep soil that has a dark colored silty surface layer that grades into a reddish brown clay subsoil. It formed in materials weathered from limestone.

Class IV Soils, colored blue on the soils map, have severe limitations that require careful management to control erosion. These soils are suitable for grassland, woodland, wildlife land or recreation land uses and for occasional but not regular cultivation.

M2D Elmont silt loam, 7 to 12 percent slopes - This is sloping and strongly sloping land that occurs on uplands. It is similar to Class III Elmont soils except for the steeper slopes.

Class VI Soils, colored orange on the soils map, have severe limitations that make them generally unsuitable for cultivation

and that restrict their use for grassland, woodland, wildlife land and recreation land.

2 Alluvial land - This land type consists of narrow floodplains along small intermittent streams where the meandering stream channel is not deeply entrenched; thus the area is subject to frequent flooding. These deep, dark colored soils are mixed and stratified.

5 Sogn-Vinland Complex - This soil complex is made up of shallow, moderately deep and deep, dark colored, silty and loamy soils that are intermixed with outcrops of limestone and shale. Slopes range from 5 to 20 percent.

Class VII Soils, colored brown on the soils map, have very severe limitations that make them unsuited for cultivation and that restrict their use largely to grazing, woodland, or wildlife.

7 Stony Steep land - This land type occurs on steeply sloping uplands. It is comprised of shallow and moderately deep, dark soils intermixed with rocky outcrops of limestone.

Other soil classifications: These two soil classifications do not occur on the laboratory site but are components of the classification system.

Class V Soils, which are colored dark green, have little or no erosion hazard but have other limitations that are normally impractical to remove that limits their use largely to pasture, range, woodland, or wildlife.

Class VIII Soils, which are colored purple, have no agricultural value because of very extreme limitations. They may have value for recreation or wildlife.

SOILS GLOSSARY

Acid soil--Generally, a soil that is acid throughout most or all parts occupied by plant roots. Commonly applied to only the plow layer or to a specific layer or horizon on the soil. Practically, this means a soil more acid than pH 6.6; precisely, a soil with a pH value less than 7.0.

Aggregate (of soil)--Many fine soil particles held in a single mass or cluster, such as a clod, granule, block, or prism.

Alkaline soil--Generally, a soil that is alkaline throughout most or all parts that is occupied by plant roots; although the term is commonly applied to only a specific layer or horizon of the soil. Precisely, any soil having a pH greater than 7.0; practically, a soil having a pH above 7.3.

Alluvial soils--Soils developing from transported and relatively recently deposited material (alluvium) with little or no modification of the original materials by soil-forming processes. (Soils with well-developed profiles that have formed from alluvium are grouped with other soils having the same kinds of profiles, not with alluvial soils.)

Alluvium--Soil material, such as sand, silt, or clay, which has been deposited on land by streams.

Association, soil--A group of soils geographically associated in a characteristic repeating pattern.

Available water-holding capacity (available moisture-holding capacity)--The capacity of a soil to retain water that can be readily absorbed by plant roots; generally expressed as a percentage of the oven-dry weight of the soil.

Bedding, soil--Arranging the surface of fields by plowing and grading into a series of elevated beds separated by shallow ditches.

Bedrock--The solid rock underlying soils at a depth of zero to many feet. Limestone and sandstone in place are examples of bedrock.

Calcareous soil--A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, diluted hydrochloric acid.

Clay--A natural material with plastic properties, composed mainly of hydrous aluminium silicates. The mineral soil particles less than 0.002 millimeter in diameter. In texture, 40% or more clay, less than 45% sand and less than 40% silt.

Clay film--A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Claypan--A compact, slowly permeable soil horizon that contains more than 35 percent clay.

Clod--A mass of soil produced by plowing or digging, which normally slakes easily with repeated wetting and drying, in contrast to a ped, which is a natural soil aggregate.

Colluvium--Sedimentary material, moved largely by gravity, deposited at the base of a slope.

Complex, soil--An intimate mixture of tiny areas of different kinds of soils that are too small to be shown separately on a publishable soil map. The whole group of soils must be shown together as a mapping unit and described as a pattern of soils.

Compressibility--Properties of a soil pertaining to its susceptibility to decrease in volume when subjected to load.

Concretions--Hard grains, pellets, or nodules of various sizes, shapes and colors consisting of concentrations of compounds that cement the soil grains together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil--The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

friable--when moist, crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed together with fingers into a lump.

loose--noncoherent; will not hold together in a mass.

firm--when moist, crushes under moderate pressure between thumb and forefinger but resistance is distinctly noticeable.

plastic--when wet, readily deformed by moderate pressure but can be pressed into a lump; will form a wire when rolled between thumb and forefinger.

sticky--when wet, adheres to other material; tends to stretch somewhat and pull apart, rather than pull free from other material.

hard--when dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

soft--when dry, breaks into powder or individual grains under very slight pressure.

cemented--hard and brittle; little affected by moistening.

very friable--when moist, soil material crushes under very gentle pressure and coheres when pressed together.

very firm--soil material crushes under strong pressure; barely crushable between thumb and forefinger.

slightly hard--when dry, soil material is weakly resistant to pressure; easily broken between thumb and forefinger.

very hard--when dry, soil material is very resistant to pressure; can be broken in the hands only with difficulty; not breakable between thumb and forefinger.

Effective depth (soil)--The depth to which a soil is readily penetrated by roots and utilized for extraction of water and plant nutrients.

Epipedon--A horizon that forms at the surface (Gr. epi, over; and pedon, soil).

Erosion--The group of processes whereby earthy or rock material is loosened or dissolved and removed from the earth's surface. The processes include running water, waves, moving ice

and winds, which use rock fragments to pound or grind other rocks to powder or sand.

accelerated erosion--erosion that has been significantly increased by human activity or by domestic animals.

gully erosion--erosion caused by intermittent moving water, creating relatively deep narrow channels in the land surface.

sheet erosion--erosion caused by water moving more or less uniformly over the land surface.

Erosion hazard--The relative susceptibility of the land to the prevailing agents of erosion.

Floodplain--The land bordering a stream, built up of alluvial sediments, and subject to inundation when the stream is at flood stage.

Glacial drift--Sediment deposited by glaciers, either left behind by the ice itself or deposited by meltwater from the glacier.

Glacial till--A conglomerate, generally clay filled with stones of various sizes, that is a product of abrasion carried on by the ice mass as it moved across the land. (For example, see Fig. 19.2, Moore, R. C., 1958, p. 497).

Gravelly soil--A soil that contains a high proportion of rock fragments of gravel size, which are rounded or subangular particles less than 3 inches in diameter.

Horizon, soil--A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

0 horizon--The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon--The mineral horizon at the surface or just below an 0 horizon. This horizon is the one in which living organisms are most active and it is therefore marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon--The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has (1) distinctive characteristics caused by accumulation of clay, sesquioxides, humus, or some combination of these; (2) prismatic or blocky structure; (3) redder or stronger colors than the A horizon; or (4) some combination of 1, 2, 3. The combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon--The weathered rock material immediately beneath the solum. This layer, commonly called the soil parent material, is presumed to be like that from which the overlying horizons were formed in most soils. If the underlying material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer--Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath the A or B horizon.

Humus--The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups--A grouping of soils based on the potential for runoff on watersheds. The groups are:

A--Low runoff potential. Well drained to excessively drained sandy soils.

B--Moderate runoff potential. Soils with moderate infiltration rates.

C--Moderately high runoff potential. Soils with slow infiltration rates.

D--High runoff potential. Very slow infiltration rates.

Liquid limit--Soil moisture content, in percent of dry weight, at which soil changes from a plastic to a liquid state. This is the water content at which a pat of soil, cut by a groove of standard dimensions, will flow together for a distance of 1/2 inch under the impact of 25 blows in a standard liquid limit apparatus.

Lithic Contact--A boundary between soil and continuous coherent underlying material. The underlying material must be sufficiently coherent when moist to make hand digging with a spade impractical.

Lithosol--A soil having little or no evidence of soil development and consisting mainly of a partly weathered mass of rock fragments or nearly barren rock.

Loamy soils--As used in this survey, soils that contain 10 to 70 percent sand, 20 to 80 percent silt, and 15 to 35 percent clay.

Loess--A fine-grained eolian deposit consisting dominantly of silt-sized particles, usually transported by wind.

Microrelief--Minor surface configurations of the land.

Mollic Epipedon--A thick, dark surface layer of a mineral soil with moderate to strong structure and at least one percent organic (0.58 percent organic carbon) content.

Mottled--Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance--few, common, and many; size--fine, medium, and coarse; and contrast--faint, distinct, and prominent. The size measurements are these: fine, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; medium, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and coarse, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Orhric epipedon (Gr. ochros, pale, light colored)--A surface layer (epipedon) that is too light in color or too low in organic matter to be a mollic epipedon.

Organic matter--The fraction consisting of decomposed or fresh remains of organisms which have accumulated on or within the soil.

Parent material (soil)--The horizon of weathered rock or partly weathered soil material from which soil has formed.

Ped--An individual natural soil aggregate such as a granule, prism, or block, in contrast to a clod, which is a mass of soil brought about by digging or other disturbance.

Pedon--A 3-dimensional body of soil with lateral dimensions large enough to permit the study of horizon shapes and relations. Usually an area of one square meter (1.2 square yards).

Percolation--The downward movement of water through soil.

Permeability, soil--The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: very slow, slow, moderately slow, moderate, moderately rapid, rapid, and very rapid.

Phase, soil--A subdivision of a soil type, series, or other unit of the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil type, for example, may be divided into phases because of differences in slope, erosion, stoniness, or some other characteristic that affects management.

Piping--The movement of soil particles by percolating water leading to the development of channels.

Plastic limit--Soil moisture content, in percent of dry weight, at which a soil changes from a semisolid to a plastic state. This is the water content at which the soil will just begin to crumble when rolled into a thread approximately 1/8 inch in diameter.

Plasticity index--The numerical difference between the liquid limit and the plastic limit; it indicates the range in moisture, for which the soil is in a plastic condition.

Plowpan--A compact and relatively impervious layer of soil formed immediately below the plowed layer; applied loosely to all compacted layers created by tillage implements.

Poorly graded soil (engineering)--A soil material consisting mainly of particles of nearly the same size. There is little difference in size of the particles in poorly graded soil material; therefore, density can be increased only slightly by compaction.

Profile, soil--A vertical section of the soil through all its horzons and extending into the parent material. See Horizon, soil.

Reaction, soil--The degree of acidity or alkalinity of a soil expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. In words the degree of acidity or alkalinity is expressed thus:

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith--The unconsolidated mantle of weathered rock and soil material on the earth's surface. Only the upper part of this, modified by organisms and other soil building forces, is regarded by soil scientists as soil. In soil mechanics, however, most engineers speak of the whole regolith, even to great depths, as "soil."

Sand--Individual rock or mineral fragments having diameters ranging from 0.05 millimeter to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Sandy soils--A broad term for soils of the sand and loamy sand classes; soil material with more than 70 percent sand and less than 10 percent clay.

Series, soil--A group of soils that have soil horizons similar in their differentiating characteristics and arrangement in the soil profile, except for the texture of the surface soil, and formed in a particular type of parent material.

Shrink-swell potential--That quality of soil that determines its volume change with change in moisture content. The volume

change of soils is influenced by the amount of moisture change and the amount and kind of clay present in the soil.

Shrinkage index--The numerical difference between the plastic and shrinkage limits.

Shrinkage limit--The maximum water content at which a reduction in water content will not cause a decrease in the volume of the soil mass. This defines the arbitrary limit between solid and semisolid states.

Silt--Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slickenside--Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur in swelling clays where there is marked change in moisture content, and at the base of a slip surface on a relatively steep slope.

Slickspots--Small areas in a field that are slick when wet because they contain excess exchangeable sodium or alkali.

Soil--A natural, 3-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over periods of time.

Soil engineering--The application of known physical, chemical, and mechanical properties of soil to its use as a primary construction material and as a foundation for structures.

Soil textural class--A classification based on the relative proportion of soil separates. The principal classes, in increasing order of the content of finer separates, are as follows: sand, loamy sand, silty clay loam, sandy clay, silty clay, and clay.

Solum--The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying parent material.

Strength, shear--The resistance of the action or force causing two contrasting layers to slide upon each other, moving apart in opposite directions parallel to the plane of their contact.

Structure, soil--The arrangement of primary soil particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular and subangular), and granular. Structureless soils are (1) single grain (each grain by itself, as in dune sand) or (2) massive (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil--The B horizon in soils with distinct profiles; roughly, the part of the profile below plow depth.

Substratum--Any layer beneath the solum, or true soil; the C or R horizon.

Subsurface layer--A transitional soil layer between the surface layer and the subsoil. It is not present in all soils.

Surface layer--A term used in nontechnical soil descriptions for one or more upper layers of soil; includes the A horizon.

Surface soil--The soil ordinarily moved in tillage or its equivalent in uncultivated soil, about 5 to 8 inches thick. The plowed layer.

Texture, soil--The relative proportions of sand, silt, and clay particles in a mass of soil. (See also Clay, Sand, and Silt) The basic textural classes in order of increasing proportions of fine particles are as follows: sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil--The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil--A presumed fertile soil or soil material, ordinarily rich in organic matter, used to topdress lawns, gardens, roadbanks, etc.

Type, soil--A subdivision of the soil series based on the differences in the texture of the surface layer. For example, Wabash silty clay. Wabash is the series name and silty clay is the type.

Variant, soil--A soil having properties believed to be sufficiently different from other known soils to justify a new series name but occurring in so limited a geographic area that creation of a new series is not believed to be justified.

Water-holding capacity--The capacity (or ability) of soil to hold water; field capacity is the amount held against gravity. The water-holding capacity of sandy soils usually considered to be low while that of clayey soils is high. May be expressed in inches of water per foot depth of soil or in inches per inch depth of soil.

Water table--The highest part of the soil or underlying rock that is wholly saturated with water.

Weed tree--Any undesirable species of tree that interferes with the development of crop trees, or one that grows where it is not wanted.

Wilting point--When the plant's rate of absorption of water is not high enough to maintain plant turgidity.

SOILS REFERENCES

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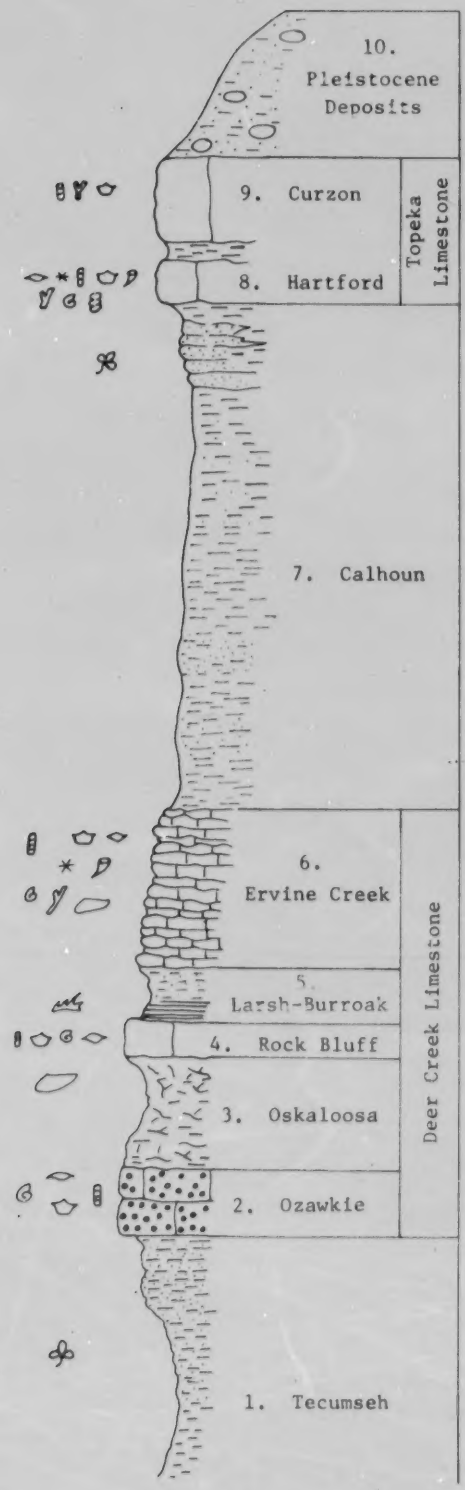
GEOLOGY

This report includes a geologic map of the bedrock of the outdoor laboratory and a descriptive text. The map shows the general patterns of the major outcropping rock units; the text describes their general characteristics.

At some places in this tract, bedrock is covered by a mantle of glacial drift or soil, or is obscured by vegetation. Therefore the lines showing the boundaries of rock units cannot be drawn with exactness at every place. This fact is not altogether a detraction from the usefulness of the map, however, because the opportunity exists for Seaman high school students to improve upon the mapping - an exercise that in itself could be a valuable learning experience.



10. Size of till particles ranges from clay to boulders. Pink quartzite fairly common.

9. Massive, weathering to dark yellowish orange.

8. Medium gray, finely crystalline, weathering yellowish brown.

7. Gray, micaceous, silty.

Symbols

- Algae
- Brachiopods
- Bryozoans
- Conodonts
- Crinoid Stems
- Fusulines
- Gastropods
- Horn Corals
- Mollusks
- Plants
- Sponges

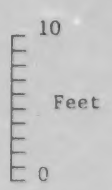
6. Light gray, wavy bedded. Weathers light brown-yellowish brown.

5. Lower part black, platy fissile shale. Upper part grayish silty clay shale.

4. Hard, bluish gray. Single bed with vertical joints.

3. Gray, blocky. Upper part grayish orange to gray, calcareous.

2. Massive, gray with oolites.



1. Bluish gray, micaceous silty to sandy shale. May contain plant fossils locally.

Figure 1.- Graphic description of rocks that are present at Seaman School Outdoor Laboratory. (Figure modified in part from Moore and Merriam, 1959, p. 17.)

U. S. DEPARTMENT OF AGRICULTURE

GEOLOGY MAP

N

LOCATION IN KANSAS

SCALE 660

USDA-SCS-LINCOLN, NEBR. 1970

SOIL CONSERVATION SERVICE

GEOLOGY MAP

SCALE 660 0 660 1320 1980 FEET

APPROXIMATE

11-9-70

5,N-28,601.5

Topography

The topography of the outdoor laboratory was formed by the normal downcutting of small tributaries of the Delaware River. The total relief is about 115 feet, and the small hills and valleys of the tract are developed upon hard limestone, shale, and sandstone of Pennsylvanian age. Locally the Pennsylvanian bedrock is covered by a mantle of Pleistocene gravel, sand, silt, and clay. The gentleness of the slopes is related mainly to the humid climate and the nature of weathering and erosion of the bedrock and the Pleistocene materials.

Stratigraphy

The laboratory is underlain by rocks that range in age from Precambrian to Pleistocene. As stated above, only sedimentary rocks of Pennsylvanian and Pleistocene ages crop out. The Pennsylvanian rocks comprise the Tecumseh Shale, Deer Creek Limestone, Calhoun Shale, and Topeka Limestone formations (Fig. 1). These units are described below in the order in which they were deposited in the Pennsylvanian seas; that is, from oldest to youngest, and from topographically lowest to topographically highest. The Pleistocene rocks are mainly clay with coarser particles that range in size from silt to boulders. The rocks are described in detail below and some characteristics are shown in Figure 1.

Tecumseh Shale Formation

The Tecumseh Shale is the oldest unit that crops out at the outdoor laboratory. It is present at the lowest altitudes and at most places is covered by soil and mantle or by thick vegetation; however, the unit is exposed in the ditch along the narrow roadway near the southeasternmost corner of the tract. The Tecumseh normally is about 65 to 75 feet thick. But, of course, only the uppermost few feet can be studied at the laboratory. The rock mainly is bluish gray, micaceous, silty to sandy shale, and it may contain plant fossils at some places.

Deer Creek Limestone Formation

The Deer Creek Formation is made up of three limestone members and two shale members (See Fig. 1). All members of the Deer Creek described below crop out in the narrow road in the southeasternmost corner of the tract.

Ozawkie Limestone Member--The Ozawkie Member (Fig. 1) is a massive bed of gray limestone about 4 feet thick and its type locality is near the former site of Ozawkie. It weathers into boulder-sized blocks, and contains brachiopods, planispiral gastropods, crinoid stems, and fusulinids. Moreover, the Ozawkie generally contains an abundance of oolites.

Oskaloosa Shale Member--The Oskaloosa Shale Member (Fig. 1) is typically exposed near Oskaloosa. The Oskaloosa is medium gray, blocky shale, containing only a few fossils. However, the uppermost few inches of the unit are grayish orange, calcareous, and contain a fauna of mollusks. The average thickness of the Oskaloosa is 6 to 7 feet.

Rock Bluff Limestone Member--The Rock Bluff (Fig. 1) is a single bed of hard, bluish gray, finely crystalline limestone that is about 2 feet thick, and that commonly is cut by vertical joints. It weathers grayish-tan and contains fusulinids, brachiopods, crinoid stems and planispiral gastropods.

Larsh-Burroak Shale Member--The lower part of the Larsh-Burroak is black, platy, fissile shale that contains conodonts. The upper part of the unit is mainly a grayish, silty, clayey shale. The entire unit is about 3 feet thick.

Ervine Creek Limestone Member--The Ervine Creek Member is light gray limestone that is distinctly wavy-bedded. It weathers to a yellowish brown to light brown color and breaks up into slabby cobble-sized or boulder-sized pieces. Horn corals and bryozoans are common in the Ervine Creek and it also contains brachiopods, fusulinids, crinoid stems, gastropods, algae and pelecypods. The average thickness of the Ervine Creek is 10 to 12 feet.

Calhoun Shale Formation

The Calhoun includes 35 to 40 feet of grayish, micaceous, silty shale and locally contains beds of sandstone. Shale and sandstone are exposed in the small rivulet along the fence line near the crest of the hill, southeast of the outdoor shelter. This exposure is only a short distance southwest of the large cottonwood tree near the center of the tract. The sandstone beds may contain a few plant fossils.

Topeka Limestone Formation

Hartford Limestone Member--The Hartford is medium gray, very finely crystalline limestone that weathers yellowish-orange or yellowish-brown. Blocks of the Hartford were turned up during construction of the restroom facilities at the laboratory, and the unit may be exposed in the grass along the crest of the ridge that trends southeastward from the shelter tent. Brachiopods, some sponges, crinoid stems, horn corals, algae, bryozoans, some fusulines and some gastropods can be found in this unit. The Hartford is 3 to 4 feet thick.

Iowa Point Shale Member--The Hartford Limestone is overlain by the Iowa Point Shale Member, which is a gray, clayey shale about 2 feet thick. Where exposed, the Iowa Point weathers to become tan, but this unit may not be exposed at all on the Seaman school tract.

Curzon Limestone Member--This unit underlies the soil in the highest area of the tract. Blocks of the Curzon also were upturned during construction of the restrooms, and the unit may be exposed elsewhere at the outdoor laboratory. Where the rock is fresh, the Curzon is medium gray, but it weathers to a dark yellowish-orange. The Curzon is massively bedded and weathers to thin slabs. Brachiopods, bryozoans and crinoid stems are contained in the Curzon and the average thickness of the unit is about 6 feet.

Pleistocene Deposits

Glacial till can be found at many places in the eastern part of the tract. A large number of pinkish quartzite boulders and cobbles are scattered about, but the Pleistocene deposits mainly are gravel, sand, silt and clay. Quartzite, weathered granite, and greenish igneous rocks or metamorphic rocks are abundant in the gravel-size particles. The Pleistocene deposits are of irregular thickness, having been eroded away in places near to streams; however, the material may be as thick as 10 feet at a few places.

GEOLOGY GLOSSARY

Algae--Several of the most primitive plants, consisting of a single cell or a cell aggregate of low organization and without a circulation system for conducting fluids. (For example, see Moore, R. C., 1958, p. 569, 571)

Bedrock--The solid rock underlying soils at a depth of zero to many feet. Limestone and sandstone in place are examples of bedrock.

Blocky--Having the tendency to break into blocks or "straight-sided" chunks.

Boulders--Detached rocks, somewhat rounded or otherwise modified in transport, with a minimum size of about 10 inches.

Brachiopods--Small, soft-bodied sea animals with upper and lower shells and two arm-like parts, one on each side of the mouth. (For example, see Moore, R. C., 1958, p. 252, 595)

Bryozoans--A large group of invertebrates that are mostly colonial and that secrete a calcareous exoskeleton. The individual organisms are quite small. (For example, see Moore, R. C., 1958, p. 592-593)

Calcareous--Containing calcium carbonate. A calcareous shale, for example, may be a material gradational between clayey shale and limestone.

Clay--A natural material with plastic properties, composed mainly of hydrous aluminium silicates. The mineral soil particles less than 0.002 millimeter in diameter. In texture, 40 percent or more clay, less than 45 percent sand and less than 40 percent silt.

Cobble-sized--Ranging from 64 mm. to 256 mm. in diameter (about 2.5 in. to about 10 in.). Cobbles are rocks detached from the original rock mass and generally are somewhat rounded by transport.

Conodonts--Extinct, microscopic spiny objects that are believed to have been mouth parts of worms or structures in the skins of fish.

Crinoid stems--Sections of the stem of the crinoid, which is made up of a number of discs. At one's first encounter, crinoid stems are reminiscent of a spinal column. (For example, see Moore, R. C., 1958, p. 315, 317, 610)

Crop out--To be exposed at the surface; to project through the soil and weathered material.

Crystalline--Of or pertaining to a crystal, having a regular molecular structure. As used in this report, a crystalline limestone is made up chiefly of very small crystals of calcite ($CaCo_3$).

Erosion--The group of processes whereby earthy or rock material is loosened or dissolved and removed from the earth's surface. The processes include running water, waves, moving ice and winds, which use rock fragments to pound or grind other rocks to powder or sand.

Fauna--The animals of any given age or region. Fauna includes animals alive or dead; therefore, fossils can be classed as fauna.

Fissile--Tending to split easily along closely spaced parallel planes.

Formation--The fundamental unit in rock stratigraphic classification. A formation is a body of rock characterized by uniformity of composition; it is prevailingly, but not necessarily, shaped like a layer in a cake, and is mappable at the earth's surface or traceable in the subsurface. (For discussion, see Moore, R. C., 1958, p. 27-28)

Fusulinids--Spindle-shaped shells of a fossil one-celled organism. They resemble grains of wheat in size and shape. (For example, see Moore, R. C., 1958, p. 234)

Gastropods--A class of the Phylum Mollusca; snails. (For example, see Moore, R. C., 1958, p. 302-303, 597-598)

Glacial drift--Sediment deposited by glaciers, either left behind by the ice itself or deposited by meltwater from the glacier.

Glacial till--A conglomerate, generally clay filled with stones of various sizes, that is a product of abrasion carried on the ice mass as it moved across the land. (For example, see Fig. 19.2, Moore, R. C., 1958, p. 497)

Granite--An igneous rock consisting dominantly of the minerals quartz and feldspar.

Gravel--Rock grains or fragments of any composition with a diameter range of 4 mm. (about 1/6 in.) and larger. Gravel includes pebbles, cobbles and boulders.

Horn corals--Fossil corals that generally are shaped like a cow's horn and that generally are rough and striated on the outside. (For example, see Moore, R. C., 1958, p. 592)

Igneous rocks--Rocks formed by solidification of hot, molten, volcanic material.

Joints--A fracture or parting that interrupts abruptly the continuity of a rock mass. Some joints cut directly through beds of rock and can be seen in exposures as straight-sided, clean fractures that extend from top to bottom of the beds. (For example, notice vertical fractures in Fig. 9.15, Moore, R. C., 1958, p. 223)

Limestone--A bedded rock consisting mainly of calcium carbonate. Many limestone units contain fossils.

Mantle--The layer of loose, weathered, incoherent rock material that lies upon hard bedrock. As used in this report, "mantle" chiefly means the unconsolidated material that lies beneath the soil and above the bedrock.

Member--A division of a formation, generally a mappable unit of somewhat local extent. (For discussion, see Moore, R. C., 1958, p. 27-28)

Metamorphic rocks--All rocks that have formed in the solid state in response to pronounced changes of temperature, pressure and chemical environment. Many metamorphic rocks are formed during periods of mountain-building when parts of the earth's crust undergo change due to high pressures and temperatures.

Micaceous--Containing the mineral mica, a clear to glassy mineral with sheetlike structure.

Mollusks--A large group of invertebrate animals, including oysters, snails, clams, brachiopods, etc. In the fossiliferous rocks of the Seaman School outdoor lab, "mollusks" generally refers to fossil clams or brachiopods.

Oolites--Small spheroidal bodies of calcium carbonate (about the size of a BB shot) that generally are contained within a bed of limestone.

Outcropping--Present at the surface of the earth but not necessarily exposed to view. For example, an outcropping bed of rock may not be visible, but could be seen if one would dig away the vegetation and soil.

Pelecypods--A mollusk that has two shells, each of which is asymmetrical but each of which is a mirror image of the other. The common mussel or "clam" is a pelecypod. (For example, see Moore, R. C., 1958, p. 302, 599)

Pennsylvanian--The sixth of the seven periods in the Paleozoic Era in the United States. (See Moore, R. C., 1958, p. 231-256)

Planispiral--Having a spiral or coiled structure, but the spiral is arranged in a plane. (For example, see the planispiral gastropod labeled "A" in Fig. 12.18, Moore, R. C., 1958, p. 303)

Platy--Having the tendency to break into platelets.

Pleistocene--The Glacial Age, or Ice Age. (See discussion in Moore, R. C., 1958, p. 46-106)

Quartzite--A granulose metamorphic rock that originally was sandstone made up of sand grains cemented together. During metamorphism the sand grains and cement become almost entirely fused.

Relief--The difference in elevation between the high point and the low point of any portion of the earth's surface.

Rock units--A general term that is used to include, say, named formations or named beds.

Sand--Individual rock or mineral fragments having diameters ranging from 0.05 millimeter to 2.0 millimeters. Most sand grains consist of quartz but they may be of any mineral composition.

Sandstone--A sedimentary rock made up of cemented grains of sand.

Sedimentary--Formed by the accumulation of material in water or air.

Shale--A laminated sedimentary rock in which the particles dominantly are clay.

Silt--Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter).

Soil--A natural, 3-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over periods of time.

Stratigraphy--The branch of geology that deals with the composition, sequence, character, age, and correlation of the rocks of an area.

Type locality--The place at which a rock formation is typically displayed and from which it is named.

Weathering--The group of processes, including chemical action of air and rain water, and of plants and bacteria and the mechanical action of changes of temperature, whereby rocks on exposure to the weather change in character, decay, and finally crumble into soil.

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GRASSLAND

The outdoor laboratory site is on the eastern edge of the largest remaining true prairie in the United States, namely the Bluestem or Flint Hills grasslands. The Flint Hills occupy a belt some 50 miles wide by 200 miles long, extending from northern Kansas south into northern Oklahoma. The principal native grasses growing in this 4.5 million acre area are tall and mid-warm season grasses. Short and mid-grasses predominate to the immediate west while a tree climax is encountered to the east.

Prior to settlement of the United States, the tall, warm season grasses occupied a vast area of our country. The same grass species found on the outdoor laboratory site were the dominant grasses found in the great true prairie region of central United States.

Rangeland discussions center around the descriptive term "range site." A range site is described as a distinctive kind of rangeland that differs from other kinds of rangeland in its potential to produce native plants.

Range site names commonly used to identify different kinds of rangelands in Kansas are as follows: breaks, clay lowland, claypan, clay upland, flint ridge, limey upland, loamy lowland, loamy upland, red clay prairie, saline lowland, sands, sandy, sandy lowland, savannah, savannah breaks, shallow flats, shallow limey, shallow prairie, shallow sandstones, shallow savannah, subirrigated and wet land.

Only one of these, loamy upland, is common to the laboratory area. It is described in detail in the following section.

U. S. DEPARTMENT OF AGRICULTURE

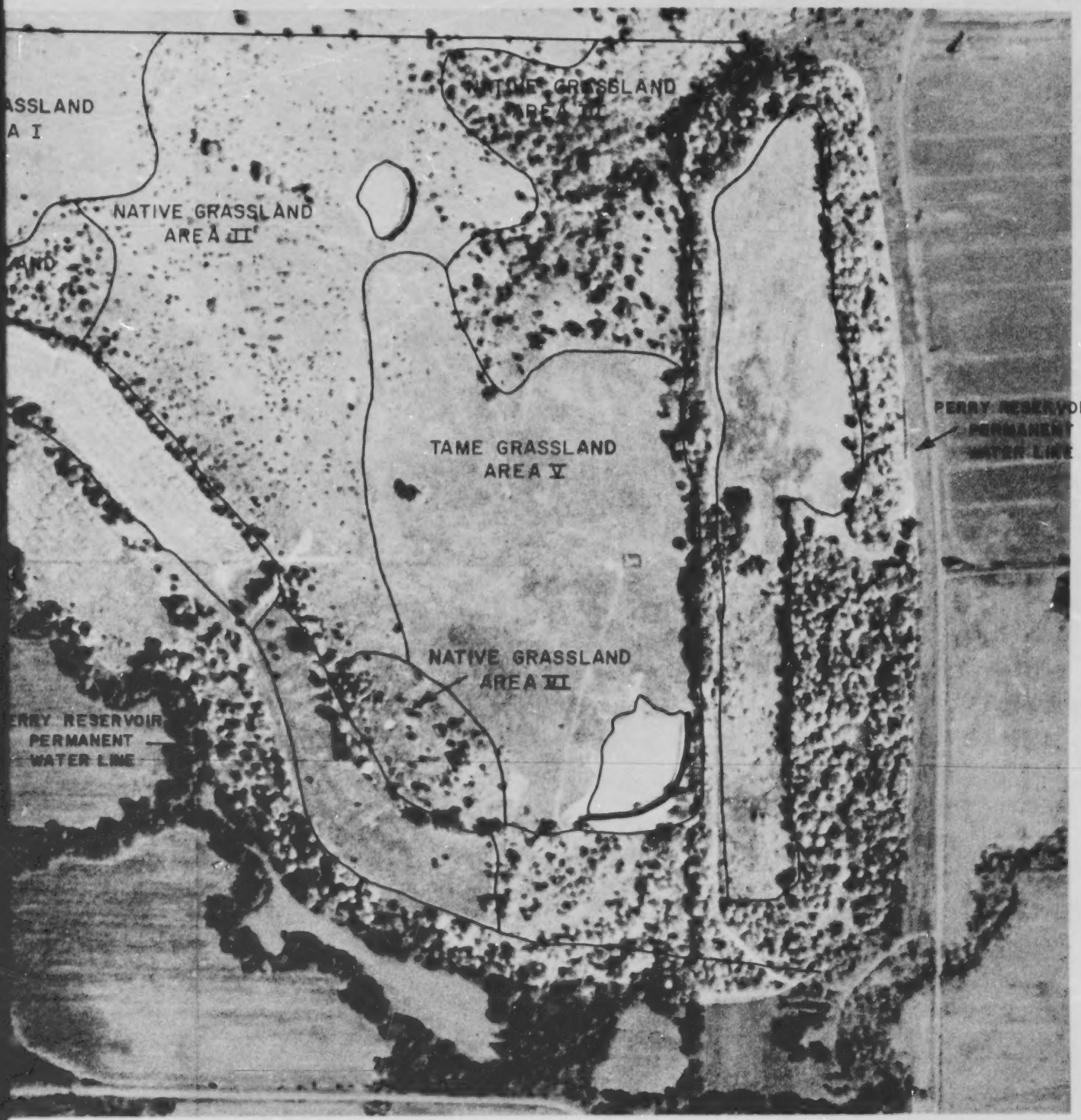
GRASSLAND MA

SCALE 660

USDA-SCS-LINCOLN, NEBR. 1970

SOIL CONSERVATION SERVICE

GRASSLAND MAP



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NATIVE GRASSLAND

A range site is a distinctive kind of rangeland in its potential to produce native plants. A range site is the product of all environmental factors responsible for its development. For any area a range site separation is considered justified if: (1) There is a measurable difference in species composition of the climax, or (2) There is sufficient difference in productivity to justify a change in the rate of grazing.

Factors influencing range sites:

1. Climate
2. Depth of soil profile
3. Mineral composition of the soil
4. Depth to water table
5. Topography
6. Soil texture

Range condition class is an expression of the degree to which the present composition, expressed in percent, has departed from that of the climax plant community of a range site. Recognized range conditions:

Name of class	Percent of present composition that is climax for the site
Excellent	76 to 100%
Good	51 to 75%
Fair	26 to 50%
Poor	0 to 25%

Decreaser plants are species in the climax plant community that decrease in relative abundance when such a community is subject to continued excessive grazing use. Usually the decrease results from excessive grazing associated with high specific animal preference for the species during the season of use involved. Some species, even though their grazing preference is low, may decrease due to adverse changes in microenvironment induced by grazing of other plants. The total of such species is counted in determining range condition class.

Increaser plants are species in the climax plant community that usually increase in relative abundance when the community is subject to continued excessive grazing use. However, not all increaser plants respond in this simple fashion. Some of moderately high grazing preference may initially increase then decrease as grazing pressure continues. Others of low grazing preference or negligible grazing value may continue to increase either in relative composition or in actual plant numbers. Under prolonged excessive grazing, increaser plants may dominate the site.

Range condition guides indicated the maximum percent composition of increaser species usually expected in the climax plant community for each site. In determining range condition class, count up to but do not exceed these maximum percentages for increaser plants.

Invader plants are not members of the climax plant community for the site. They invade the community as a result of various kinds of disturbance. They are not restricted to exotics, however, as they may be normal components of the climax plant community on other range sites in the same locality. They may be woody or herbaceous annuals or perennials. Their forage value and relative grazing preference may be high or low. Invader plants are not counted in determining range condition class.

Native Grassland

Area II on Grassland Map

Range site: Loamy upland.

History: Native grassland, previously heavily grazed; evidence exists that portion of the area may have been in cultivation in the past.

Current vegetation: Native grasses predominate.

Decreasers present: Big bluestem, little bluestem, switchgrass, Illinois bundleflower, roundhead lespedeza, leadplant amorpha.

Decreasers missing: Pitchers sage, compassplant, ashy and willow leaf sunflower, Jersey tea ceanothus.

Increasers present: Sideoats grama, tall dropseed, goldenrod, western ragweed, Kentucky bluegrass, heath aster.

Increasers missing: Scurf pea, indigo plant.

Invaders: Broomweed, broomsedge bluestem, smooth brome, Korean lespedeza.

Trees and shrubs: Osage orange, smooth sumac, rough dogwood, coral berry (buck brush), red cedar.

Condition class: Fair.

Area III and IV

Range site: Loamy upland (shallow phase).

History: Native grassland heavily grazed.

Current vegetation: Native grasses virtually gone, trees and brush have taken over. Scattered clumps of sideoats grama, switchgrass, indigo, tall dropseed, big bluestem, and little bluestem. Smooth bromegrass and Korean lespedeza are also members of the present plant community.

Condition class: Poor, due to tree invasion.

Area VI

Range site: Loamy upland.

History: Native grass; may have been a building site many years ago.

Current vegetation:

Decreasers present: Big bluestem, little bluestem, switchgrass, indiangrass, Illinois bundleflower, roundhead lespedeza.

Decreasers missing: Pitchers sage, compassplant, leadplant amorpha.

Increasers present: Tall dropseed, goldenrod, scurf pea.

Invaders present: Mullin, ragweed.

Trees and brush: Red cedar, osage orange, American elm, rough dogwood, smooth sumac, coral berry (buck brush).

Condition class: Good.

Loamy Upland Range Site

The principal forage production on this site when in climax condition is from big bluestem, little bluestem, indiangrass, switchgrass, prairieclover, and leadplant amorpha. When overused, sideoats grama, tall dropseed, and blue grama increase at the expense of the decreasers. Annual grasses, Kentucky bluegrass, and forb invaders replace the better grasses and forbs when grazing is severe for several years.

Decreasers make up to 85 percent or more of the total production when in climax condition, with increasers accounting for the remainder.

The total annual yield of this site, when in excellent condition, based on plot clippings will average approximately 5,000 pounds per acre but may vary from 6,000 pounds in favorable years to around 4,000 in unfavorable years. This range site tends to be more consistent in annual production over its counterpart, clay uplands.

All grasses and forbs have an inherent capacity to produce and to be harvested in order for them to perform properly. Constant non-use will cause most of the desirable grasses and forbs, the decreasers, to first stalemate and then to deteriorate. The accumulation of dead stems, leaves, and trapped mulching material have a dampening effect on new plant production resulting in plants going out and being replaced by less desirable ones. Thus to keep the climax grasses in excellent condition, a harvest should be made through grazing, through haying and removing or by controlled burning one year in every three or four.

There is another important consideration in native grasslands where non-use is practiced. Total non-use is not natural for these grasslands. The elimination of grazing, mowing, and fire from the environment will upset the ecology of the area and tip the balance in favor of woody plants. Grazing alone has little

influence in the control of woody plant invasion. On the contrary, overgrazing usually encourages these invasions. Mowing, periodic burning, and/or a vigorous chemical spraying and mechanical removal are needed to control invaders.

Climax vegetation for this site:

Decreasers:

Big bluestem	Andropogon gerardi
Little bluestem	Andropogon scoparius
Indiangrass	Sorghastrum nutans
Switchgrass	Panicum virgatum
Prairie clovers	Petalosteman purpureus
Leadplant amorpha	Amorpha canescens
Jersey tea ceanothus	Ceanothus ovatus
Maximillian sunflower	Helianthus
Ashy sunflower	Helianthus mollis
Willow leaf sunflower	Helianthus salicifolius
Pitchers sage	Salvia pitcheri
Compassplant	Silphium laciniatum

Increasers:

Sideoats grama	Bouteloua curtipendula
Western wheatgrass	Agropyron smithii
Blue grama	Bouteloua gracilis
Buffalo grass	Buchloe dactyloides
Tall dropseed	Sporobolus asper
Heath aster	Aster ericoides
Western ragweed	Ambrosia psitoslachya
Stiff goldenrod	Solidago rigida
Indigo plant	Baptisia australis
Wild alfalfa	Psoralea tenuiflora

Invaders:

Broomweed	Amphiachyris dracunculoides
Annual threeawn	Artistida oligantha
Annual (Japanese) brome	Bromus japonicus
Silver bluestem	Andropogan saccharoides
Musk thistle	Carduus nutans L.

Decreaser Plants

Big bluestem is a native, warm season, tall, perennial grass. It has short, scaley underground stems (rhizomes) and roots which fill the upper two feet of soil profile and reach to depths up to 12 feet. Growth begins in early April, culminating in seed stalks three to eight feet tall in late August to early October. The seedheads are usually in three segments resembling the toes on a turkey's foot. The young shoots are somewhat flattened at the base and the lower leaves are usually covered with silky hair. It is a clump grass and is extremely leafy. After frost the mature plants have a reddish cast.

Few, if any, of the prairie grasses can equal big bluestem in quality or quantity of forage produced. It is usually preferred by livestock over the other grasses consequently it has a high degree of utilization. Grazing intensity, where the leafy stems are consistently utilized closer than six to eight inches, will cause big bluestem to go out and be replaced by less desirable plants.

Little bluestem is a native, warm-season, mid-height, perennial grass with a dense root system reaching five to eight feet in depth. It is a bunch grass spreading by seed and tillers. Growth starts in early April, culminating in seed stalks two to five feet tall from late August to October. It may be identified by its flat, bluish-colored based shoots and leaf blades which tend to droop. Mature plants have a reddish cast after frost giving rise to the term of "red tuft" grass often used by ranchers. It is one of the most widely distributed range grasses in America, producing one to two tons of forage per acre per season. It is good winter pasture when supplemented with protein and minerals. Continuously grazing little bluestem closer than four to six inches is detrimental to the grass, and it will be replaced by less desirable grasses and weeds.

Indiangrass is a warm-season, native, tall grass reproducing from seeds and short, scaley underground stems. It is easily identified by the seedhead and the claw-like ligule where the leaf blade attaches to the sheath. Indiangrass is a very important tall grass both for green forage and dry cured hay. It is preferred by all classes of livestock, having a high plant utilization factor. Like the other tall grasses it will not tolerate continuous grazing where less than five to eight inches of plant is maintained through the grazing season. Indiangrass is increasing in

popularity both in pure stands and in mixtures with other tall grasses. It responds well in forage and seed production when nitrogen fertilizer is applied.

Switchgrass is a native, warm season, perennial sod forming tall grass with vigorous roots. It reproduces from seed and rhizomes. Its identifying characteristic is a dense nest of hair where the leaf blade attaches to the sheath. Switchgrass has a sprangle-type seedhead on seed stalks three to six feet tall. It is highly preferred by livestock and enjoys a high degree of use. It grows best on lower lying and moist soils, yet it has an extensive root system enabling it to be really winter-hardy and drouth resistant. Like the other tall grasses, it will not tolerate close grazing. Maintaining shorter than five to seven inches top growth throughout the grazing season will reduce vigor.

Prairie clover is a deep-rooted, warm season, perennial, native legume reproducing from underground stems (rhizomes) and seeds. Its growth height is one to two feet and has a cone-type purple seed-head. The single base growing crown may have from 10 to 30 stems with short, pine needle-like leaves. The young plants have an exceptionally high protein content. It is considered by many botanists as third in importance among the native range legumes.

Leadplant amorpha is a deep-rooted, warm-season, perennial, shrubby legume which reproduces from seed. It reaches a height of two and one-half to four feet with stems up to one-half inch in diameter. It has small, dark purplish flowers with single petals. These single petals, however, are so numerous on the seedhead, they appear as a cluster. Leadplant is one of the most important native prairie legumes and is preferred by livestock.

Ashy sunflower and willow leaf sunflower are perennial forbs which reproduce by seeds and by strongly branched roots or rhizomes. Both have the typical sunflower inflorescence, golden petals, and dark brown centers. The leafing characteristics are as the names imply. The leaves of the ashy species have soft hairy under surfaces and a grayish-green surface. The leaves are small and on alternate intervals on the main stems. The willow leaf species has long, narrow, drooping leaves nearly hiding the slender stems. Both are sensitive "decreasers" and have very high preference and degree of use rating.

Pitchers sage is a native, warm season, deep rooted, perennial forb growing from two to four feet tall. It begins growth early in the spring and its pale green flowers may be seen from May until late fall. The identifying characteristics are a square stem, alternate and opposite leaves. It is very readily used by range livestock particularly in early spring. It is a sensitive decreaser, easily being over-utilized.

Jersey tea ceanothus is a small semi-shrub forb, warm season, growing primarily on limey and stone outcrops. It has numerous white, small flowers appearing in late April to mid June. Ceanothus is a very sensitive decreaser, enjoys a high preference by livestock and is easily over-utilized. The plant is not common in grassed areas where livestock have the opportunity to fully utilize the grazing areas.

Increaser Plants

Sideoats grama is a native, warm season, perennial mid range grass with short scaley rhizomes. Growth begins in early April and seed stalks appear July through September standing 18 to 36 inches tall. Identifying characteristics are the distinctive seed arrangements with seeds hanging only on one side of the seed stem and the flat leaf blades with regularly spaced bumps and one hair in each bump along the leaf margins. Sideoats grama will increase to replace other grasses when grazing pressures push the decreasers out. However, if grazing pressure continues and sideoats is continuously grazed to a two to three inch level, the plant vigor decreases and it will also go out.

Western wheatgrass is a cool season perennial that spreads strongly and grows persistently. It is 12 to 24 inches tall, has gray-blue, waxy coated heavily veined, stiff leaves. It spreads by strong rhizomes and seeds. The forage is readily consumed by livestock until seedheads appear, then the stems and leaves become coarse and spiney, causing grazing animals to prefer other grasses.

Blue grama is a native, warm season, perennial, short grass with seedheads 10 to 20 inches tall. It forms a low bunchy sod and reproduces only by seeds. The seedheads form an arch like a human eyebrow as they mature. The poundage of forage produced is quite low but the preference and use ratings are quite high and it retains its nutritive value for winter grazing. It is

an increaser but will not continue to increase when grazed continually closer than two to three inches during the growing season.

Buffalo grass is a native, perennial, warm season, sod forming, short grass which reproduces by seeds and by vigorous surface runners (stolons) which root at the joints. Buffalo grass seldom grows to heights greater than five inches. It can resist being grazed out since it can tolerate close grazing - one-half to one inch. However, it is most vigorous and reproductive one to three inches of forage is maintained. Buffalo grass cures well in the pasture making excellent winter grazing in drier areas. It enjoys a high preference and high use rating.

Tall dropseed is a native, warm season, perennial bunch grass growing to a height of two to four feet. It is quite drought resistant, produces seeds in a great quantity, and spreads through seed distribution. It enjoys a rather high forage preference during the time the leaves and stems are growing rapidly. However, this preference is short-lived. The grass is easily identified after maturity by the long, slender basal leaves, the short top leaves, and the waving in the breeze giving rise to the term "flaggrass."

Heath aster is a native, warm season, deep rooted, perennial forb which reproduces from much-branched, vigorous rhizomes and seed. It makes rapid growth in the spring and enjoys a high grazing preference for a short time, which reduces to nil as the plant flowers and matures. Identifying characteristics include a profusion of one-fourth inch diameter purplish-white flowers often so numerous they hide the rest of the vegetative parts.

Western ragweed is a native, warm season, perennial forb which reproduces by seeds and long, tough rhizomes. The erect stems one to two feet tall branch into a bushy growth and are covered with dense, minute hairs. The plants flower from June to October. Livestock do not graze it, except in the early spring or during the late summer months when forage is short. It is during these periods when the grasses are in stress that the ragweed makes rapid advances in becoming established. At these times it performs and is often regarded as an invader instead of an increaser.

Stiff goldenrod is a native, warm season, deep rooted perennial forb that reproduces by seed and shoots from heavy root stocks. The stems are two to four feet tall, stout, branched slightly at the top and may appear singly but usually occur in clumps. The mass of tiny, beautiful, golden flowers appear from August to October. Goldenrod is readily eaten by livestock until flowers and seedheads appear. Then there is usually sharp drop in use.

Invader Plants

Annual broomweed is a native, warm season, annual forb which reproduces by seed. It has woody, tough stems 15 to 30 inches tall branching at the top to form a rather uniformly round corner. It has a strong taproot which will penetrate to two feet depths. A mass of tiny bright yellow flowers appear in August to October. The small needle-like leaves and fine-branched crown afford relatively little surface for moisture evaporation plus its unpalatability has enabled this weedy pest to spread rapidly in abused pastures and ranges during a drouth. It is no problem on well managed pastures and ranges. There is a toxic agent either in the leaves or pollen which under certain circumstances causes inflammation of the eye both in man and livestock.

Prairie threeawn is a native, shallow rooted, warm season, tufted, annual grass reproducing from seeds. It grows one to two feet tall, branching freely at the base and lower nodes. The narrow leaves taper to a point. Each seed has three awns, one to two and one-half inches in length, spirally curved at the base. It has a variety of common names, including whitegrass, wiregrass, tickle grass, and dog hairgrass. It is unpalatable, except when very young.

Japanese brome is an introduced, cool season, shallow rooted annual which reproduces by seed. The stems are erect or spreading at the base from 12 to 30 inches tall, often nodding when mature. This cool season grass germinates in the fall, remains green during winter, and produces seed in May and June. It was introduced from Asia and is now growing on a variety of soils throughout the United States. It is a common invader on abused ranges where climax grasses are thinned out and is especially noticeable during a wet fall or winter. Other common names are: Japanese chess, wintergrass, and june grass. It is occasionally referred to as "rescue" grass.

Silver bluestem is a native, warm season perennial bunch grass which grows to a height of two to four feet. It reproduces by rooting at the nodes of low stems and from seed. Its identifying traits are: slender, silver colored seedheads; main stems crooking from side to side at the nodes; often a ring of stiff hair at the nodes; and the seed borne in tufts of fine silky hair. It has a low grazing preference and only in the early growth stages. It is a pest invader on overgrazed and abused pastures and ranges.

Musk thistle is a biennial plant which reproduces by air borne seeds; it grows from two to seven feet tall. The leaves are dark green, smooth and waxy, deeply lobed, three to six inches long and very prickly. The heads are solitary, large, deep reddish purple, nodding on the end of the main stem or major branches. Grazing of this pest has not been observed when any other forage is available.

Tame Grassland

Cool season grasses, as opposed to the warm season or range type grasses, also exist on the laboratory area. They are grown for their forage and in general are easily established. They fill a definite need of the livestock industry, as they are a means of providing quick ground cover and lengthen out the grazing season by providing early and late season growth.

Area I

History: Formerly in cropland, now seeded to cool season grasses.

Present vegetation: Smooth brome, Kentucky bluegrass, Korean lespedeza. A few scattered clumps of native grasses are becoming established.

Condition: Fair on the mowed portions, only scattered brush and weed invasions.

Bromegrass is a perennial sod forming grass spreading from strong rhizomes. It grows 18 to 48 inches tall, has leaves 3/16 to 3/8 inch wide with a distinctly impressed "W" or "M" hinge in the upper one-third of each leaf blade. Growth starts in late March or early April. Seedheads appear in June. The seedheads are four to eight inches long and spreading. Brome is

dormant from the time seeds are ripe until late August when cooler night temperatures and seasonal rainfall recur. Brome is one of the most important cool season grasses in eastern Kansas, as well as under irrigated conditions in central and western Kansas. It is highly desired for grazing, hay, and seed production.

Kentucky (K-31) fescue is a perennial clump forming grass spreading from strong rhizomes. It grows from 15 to 36 inches tall. Growth starts in mid March. Seedheads appear in June. Following seed maturity, the grass goes into a dormant period till August when seasonal rains resume. Fescue tolerates wetter soil conditions than brome will. It will grow on shallow soils but responds readily to fertilizing. It will produce heavily when plant food and moisture are ample. It is, however, less drought resistant than brome, lacks brome's palatability and frequently causes disease to grazing animals termed "fescue foot." Livestock develop lameness and sloughing of the hooves when this disease attacks. The attacking fungus usually is activated following a severe frost or snow where livestock is grazing the summers' accumulated growth. Livestock men soon learn to avoid grazing when these conditions are present. In spite of these deficiencies, K-31 fescue acreage continues to increase all over the geographic area where the grass is adapted.

Orchardgrass is a short-lived perennial clump-producing grass spread by weak rhizomes. It needs deep and fertile soil with plenty of moisture available and the air temperatues generally below 90 degrees. Orchardgrass grows from 15 to 48 inches in height. Growth starts in March and the first seedheads appear about six weeks later. At this point the seed bearing stems and most of the plant go into dormancy. The palatability drops materially. Only a fringe of the leaves near the ground stay succulent and palatable. Dormancy will then be broken when the next rains come. Mowing and removing the dormant plant parts as soon as seedheads appear will stimulate the growing lower leaves into another attempt to go through another cycle of growth and new seedhead production. In a climate of ample rainfall or when under irrigation this recycling can be repeated several times or until the air temperature becomes high enough to put the plant into dormancy in spite of watering. Orchardgrass is not commonly grown alone but in a mixture of clover, alfalfa, brome or timothy. Growers of orchardgrass are enthusiastic about it and report livestock often prefer to graze or consume it as hay, even in preference to the other grasses in the mix. Management

requires annual application of fertilizer for maximum production. Apply lime in conformity with soil test at time of establishment. It takes annual application of 80 to 120 pounds available nitrogen, 30 to 40 pounds phosphate, and 20 to 30 pounds potash per acre, depending on soil tests. A split application of three-fourths the annual amount in late winter and the balance in August is preferred. Avoid grazing so heavily that a top growth of less than four inches is maintained through the season. Burning the dead residue is definitely detrimental. Be prepared to eradicate invading trees and brush especially osage orange, honey locust, and red cedar. Acid chemical sprays are usually preferred for this. Mowing for hay production is best during the bloom stage of the seedheads. These species are readily established or reestablished if necessary.

Bluegrass has growth habits much like smooth bromegrass, except it has a longer dormant season in the summer. Since bluegrass is a short grass, it will tolerate grazing to heights of two to two and one-half inches without damage. It is often supplemented by legumes such as Dutch white clover, red clover, and Korean lespedeza. It lends itself best to grazing, seed production, and sod harvesting. Fertilizing for grazing is usually not economical.

Musk thistle (nodding thistle) is a biennial plant which reproduces by air borne seeds; it grows from 2 to 7 feet tall. The leaves are dark green, smooth and waxy, deeply lobed, 3 to 6 inches in length, very prickly. The heads are solitary, large, deep reddish purple, nodding on the end of the main stem or major branches. Grazing of this pest has been unobserved when any other forage is available. State law requires its eradication where found.

GRASSLAND PLOTS

Native (warm season) and cool season plants are often grown in pure stands under intensive management. Grasses grown under controlled conditions are a source of seed for propagation. These same conditions help plant geneticists study and improve the growth habits of a particular variety or strain.

Grass demonstration plots will be established on the outdoor laboratory to provide a means of identification in all stages of growth and for comparison between managed and unmanaged areas.

Warm season grasses begin growth about May 1, as the temperature approaches 60 degrees. They grow rapidly and start seedheads in late July or August. The seed normally ripens in late September. The plant then goes into winter dormancy and another life cycle begins the next spring. These grasses are perennials. They are self-sufficient and tolerate the natural pressures of droughty years, wet years, fire, erratic grazing, and the invasion of insects and pests. In other words, they have adapted themselves to their natural environmental without the influences of man.

Cool season grasses have been domesticated in part or in their entirety for fitting man's needs. Growth starts in the spring when temperatures approach the 40 degree range. Maturity and seed production is usually accomplished before hot and dry weather conditions arrive. The plants then become dormant until early fall, or until such time as the temperature moderates and moisture conditions are more favorable. Growth continues through fall months until severe weather stops favorable growing conditions. Cool season grasses require intensive management measures if maximum production is to be achieved.

A limited number of each of the native and cool season grasses are listed as suggested varieties for the grass demonstration plots. Additional varieties may be added to both plots as desired, since there are unlimited possibilities, including the so-called turf grasses.

Warm season grasses:

- Big bluestem
- Little bluestem
- Indiangrass
- Switchgrass
- Side oats grama
- Blue grama
- Buffalo grass
- Prairie cordgrass
- Eastern gama

Cool Season grasses:

- Smooth bromegrass
- Kentucky fescue
- Bluegrass
- Meadow fescue
- Tall wheatgrass
- Intermediate wheatgrass
- Orchardgrass
- Perennial rye grass
- Timothy

Plantings in single rows should be 10 to 20 feet long with about three feet between rows.

Care and maintenance of the grass plots: The plots will need cultivating, harvesting, and fertilizing to maintain them and to provide the use cycle that they would normally go through under typical farm or ranch use.

Warm season grasses generally are not fertilized. Their response to such treatment is questionable under natural conditions. A limited amount in the plots could be applied to increase vegetative growth if on exceptionally poor soils. Cultivating: Since the plots will be established in rows, it will be necessary to keep the space between rows clean tilled until the grasses are well established. Harvesting: Each year's annual growth should be removed mechanically. The residue can be burned periodically, if timing and any fire hazard is considered.

Cool season grasses benefit greatly from the annual application of commercial fertilizers. The fertilizer would best be applied based on the analysis of a soil test. Cultivating: As in the warm season plots, cultivation should be practiced until the grasses are well established. Harvesting: Each year's annual growth should be removed after maturity to simulate conditions of actual use.

GRASSLAND GLOSSARY

Alfalfa--A perennial legume grown for hay production. An important cultivated crop.

Alternate--Leaf's appearance at regular intervals at a central stem on a left, right, left, right system.

Annual--A plant that completes its life cycle in one year.

Association (of species)--A grouping, a composite mixture of plants occupying a common site in a harmonious state of growth over an extended period of years.

Biennial--A two-year period of time. Biennial plants require two calendar years or two growing seasons to complete their life cycles.

Bluegrass--See grassland section - cool season grasses.

Bromegrass--See grassland section - cool season grasses.

Climax--The highest order of a plant association which can be supported on any given site. The climax plant community is reached when full use is made of the available natural resources, soil, plant food, moisture, sunshine and temperature.

Clover--A group of leguminous plants which are either annual, biennial, or perennial in their life cycles. Clovers are native and domesticated. Some are harvested by grazing animals in the green stage or are cured for hay. Many are not palatable but their seed is used by birds, rodents and other small animals.

Cluster--Commonly, the flowering parts of plants.

Cool season grasses--Grasses that perform best when the temperature ranges between 42 and 90 degrees; bluegrass and bromegrass are the most common. Seed is produced prior to the hot season, dormancy follows until moisture and cool temperatures revive the plant.

Community--An assembly of plants living on a common site under similar conditions and influenced by common environment.

Condition--The general health and vigor of plant species occupying a specific plant community.

Cone type--A botanical term describing the seedheads of a certain plant.

Decreaser plants--See grassland section range sites.

Degree of utilization--An index of the percent of forage removed annually in relation to the total forage produced.

Deteriorate--The process of declining from a normal status of health, vigor, age or ability to perform.

Dominant--A position of mastery through numbers or influence on surrounding plants.

Dormant--The suspension of growth habits by plants during periods of adversity.

Drought resistant--The ability of plants to cope with long periods of little or no moisture.

Ecology--The relationship between plants and the influences of the environment in which they are growing.

Environment--Outside factors influencing the development and functions of a plant.

Excessive grazing--The removal of the above ground forage produced by a plant at a rate and over a long period of time, whereby the plant is injured in producing additional forage.

Exotic--A plant not found under natural conditions.

Forage--The above ground growth of warm and cool season grasses.

Forb--An annual or biennial herbaceous plant which dies back to the ground at the end of the grazing season.

Germinate--To begin to grow from seed.

Growing crown--The mass of plant material located between the roots and the stems with their leaves.

Grass--A member of the family Poaceae.

Herbaceous--Flowering plants whose stems and leaves above ground do not become woody.

Increaser plants--See range site descriptions.

Inflorescense--The flowering part of a plant.

Introduced--A plant that has been brought into an area from a remote place.

Invader plants--See range site descriptions.

Kentucky fescue--See grassland section, cool season grasses.

Legume--A plant of the family Legummacae. It is used for feed and soil improvement.

Ligule--A tongue-like collar at the base of the leaf blade which partially or wholly surrounds the stem.

Lobed--A rounded projection or ear-like part. Often used to describe plant leaves.

Microenvironment--Factors influencing the development and functioning of micro-organisms such as fungi or molds found in the soils.

Mid grass--Native grasses that grow 18 inches to 3 feet high when mature.

Mulching--Vegetative residue which has been artificially placed on seedbeds to increase water intake, smother weeds to prevent erosion or otherwise benefit plants or seedbeds.

Native grassland--An area covered with natural warm season grasses indigenous to the area. It has evolved into a plant community after a long period of being influenced by the environment of a site.

Nodes--A joint in a plant stem. Often a point where leaves originate.

Opposite--A leaf arrangement in grasses. The leaves are directly opposite to one another.

Orchardgrass--See grassland section, cool season grasses.

Outcrop--A physical feature of the land. Rock is present at the surface of the earth but not necessarily exposed to view. Easily exposed by digging.

Overgrazed--Forage removed by livestock through the entire season to such an extent that plant vigor is reduced.

Palatability--Expressing the relative relish with which food is consumed.

Perennial--A period of time greater than two years.

Petals--The parts of a flower, often gaily colored to attract insects.

Physical sites--Geographical locations.

Plant vigor--Plant health reflected in its size as related to age and environment.

Pollen--The fertilizing elements of flowering plants consisting of fine, powdery, yellowish grains or spores.

Prairie--A large land area on gently rolling or level land in the Mississippi Valley. The chief grasses are warm season native species. Big bluestem, little bluestem, indiangrass are the predominant species. Other species become important in the composition as the environment changes from and to wet, from sands to clays and from upland to lowland.

Proper utilization--Grazing grassland at an intensity which will maintain adequate cover for soil protection and either maintain or improve the quantity and quality of desirable vegetation.

Range--The native pastureland areas where climate or soils dictate a grass climax cover.

Range condition--Refer to grassland section definitions.

Range site--Refer to grassland section definitions.

Recycling--Beginning another cycle of plant functions, such as seedhead production, re-emergence of growth points when the first set was damaged or destroyed by grazing.

Rhizomes--Underground stems arising from the main plant (growth crown) which produce roots below and leaves above as a means by which a plant spreads.

Segments--Parts into which anything naturally separates or is naturally divided.

Sheath--The leaf base when it forms a vertical coating surrounding the stem.

Shoot--New or young growth arising from the plant. These shoots are tender, grow rapidly, are usually palatable though vulnerable to damage from grazing.

Short grass--Native grasses that grow 6 to 18 inches high when mature.

Silky--Resembling silk by sight or touch.

Sod forming--Sod forming grasses are so called when they form a dense, continuous cover like a carpet.

Soil profile--A vertical section of the soil through all its horizons and extending into the parent material.

Soil texture--The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes in order of increasing proportions of fine particles are as follows: Sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, loamy sand, and sandy loam classes may be further divided by specifying coarse, fine, or very fine.

Species--A basic class of plants having some common characteristics or qualities. Any variation existing among individual plants are regarded as not affecting the essential sameness which distinguishes them from all other organisms.

Sprangle--A seedhead. The seeds are attached to stiff hair-like stems and literally sprangle out in many directions from the central stem. A loose almost unsymmetrical seed-bearing head.

Stalemate--A deadlock. One function cannot be carried out because of the failure of another function to act.

Stems--The elongated above ground, normally erect plants which support the branches and leaves of plants.

Stolon--An above ground stem, lying prostrate on the soil surface.

Stress--A load, force or system of forces interfering with the free function of a plant, such as a lack of nutrients.

Succulent--A plant is succulent when it has fleshy and juicy tissues.

Tall grass--Native grasses that grow 3 to 6 feet high when mature.

Taproot--A sturdy central root designed to penetrate deeply into the soil profile.

Tillers--Shoots growing from the base of a plant, thereby increasing the number of stems for the adult plant.

Timothy--A cool season grass, perennial in growth habit; at one time a noted hay grass for horses.

Topography--Surface features of an area denoting relief or elevations.

Warm season grass--A term referring specifically to the grasses which carry out their functions most efficiently during the warmer months.

Winter hardy--Resistant to damages from winter temperatures.

Woody--Persistant, tough, non-grazable plant tissues such as shrubs, brush or trees.

GRASSLAND REFERENCES

Kansas Technical Range Site Descriptions, USDA, Soil Conservation Service Technical Guides.

Stoddard, Lawrence A. and Smith, Arthur D., Range Management.

SCS Classifying Rangeland for Conservation Planning, Agricultural Handbook No. 235, USDA.

Phillips Petroleum Company, Native Grasses, Legumes, and Forbs, Series 1 through 6.

Kansas State Board of Agriculture, Noxious Weeds 7-63.

National Handbook for Range and Related Grazing Lands, USDA, Soil Conservation Service.

WOODLAND INVENTORY

This report consists of four sections: A forestry map, a descriptive text, a glossary and a list of selected references. The map shows the location of the woodland areas, including the two square one-acre sample plots. The text describes the forestry resource and relates its importance to Kansas and the Nation. The glossary contains definitions of forestry terms. The sections of woodland, windbreak, Christmas trees, and arboretum normally would appear under Woodland in the conservation plan but are included here for ease of reference and teacher use. The selected references will assist the student and teacher alike in the search for more in-depth information.

U. S. DEPARTMENT OF AGRICULTURE

WOODLAND MAP

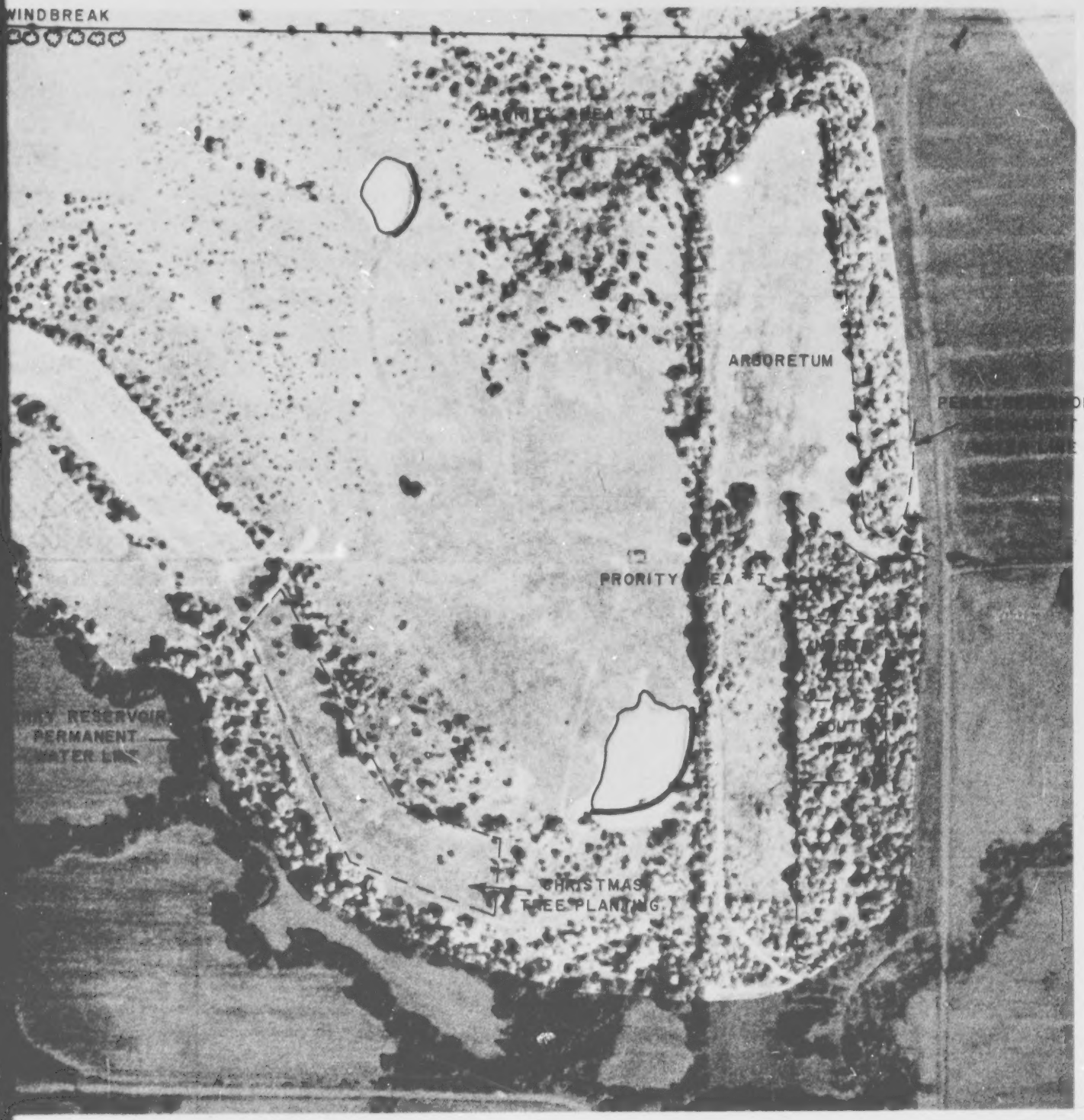
N

LOCATION IN KANSAS

SCALE 660

SOIL CONSERVATION SERVICE

WOODLAND MAP



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FORESTRY RESOURCES

The outdoor laboratory forestry resource is typical of thousands of acres of the same forest sub-type, upland plains hardwoods in eastern Kansas.

Timber stands of similar character in composition and development, due to certain ecological factors that can be differentiated from other stands, are considered as a forest type, with the sub-type being a further refinement in identification.

The general forest type for the upland plains hardwoods sub-type is the upland oak-hickory type. Walnut is also found in another Kansas forest type: the elm-ash-cottonwood.

There are two variations of the upland plains hardwoods sub-type represented on the laboratory area. Priority Area I (see map) is comprised of black walnut as the major species, whereas Priority Area II consists of hackberry and American elm, with almost a total exclusion of walnut. For detailed information on species composition please refer to the woodland subsection under description of woodland condition.

Kansas ranks high in the volume and value of walnut timber. In 1963 Kansas was second in the nation in the production of veneer quality walnut logs for domestic mill use. Kansas ranked fifth nationwide in the net volume of walnut growing stock and seventh in the net volume of walnut sawtimber[1].

Most of the nation's black walnut resource is scattered on small private tracts. This is also true on the laboratory area. When properly managed, these tracts have a tremendous economic potential. In Kansas alone the stumpage value of walnut timber harvested in 1963 was conservatively placed at $5,000,000. When the multiplier effect on the state's economy is considered, the resultant figure is very impressive indeed!

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1 A Look at Black Walnut Timber Resources and Industries, Quigley, Kenneth L. and Lindmark, Ronald D., U. S. Forest Service Resource Bulletin NE-4, 1967.

As mentioned in the woodland subsection, two square one-acre plots were established. These plots were 100% inventoried of the primary species, one-inch d. b. h. and larger. The data from this inventory was used to determine the present and future management prescriptions, including volume projections, set forth in the woodland plan. The plot boundaries will be permanently marked for future inventories. Periodic inventories will provide a check on the growth of the timber and will furnish the necessary data for refinements in the present management plan.

WOODLAND

Description of woodland condition: Both areas, priority area I and priority area II, (see woodland map) are located on an upland site and have a relatively steep slope on the east side. No indications of past timber management practices can be found. Fortunately wildfire hasn't caused any noticeable damage to the timber resource on either of these areas. Grapevines infest many of the potential crop trees.

Priority area I, has a much higher timber production potential than priority area II because of a deeper soil and a more gentle slope on the east. This area consists of 7.5 acres of seedling to pole size black walnut timber as the primary species in the overstory. Associated species are American elm and hackberry. Secondary associated species include: Eastern redcedar, black cherry, osage orange, box elder and honey locust.

Understory species consist of: roughleaf dogwood, red mulberry, smooth sumac, greenbriar, gooseberry, blackberry, buckbrush, bittersweet, and grapevines.

Stocking of desirable species, almost entirely walnut, ranges from understocked to overstocked, with the area as a whole being in an overstocked condition. It is classed as overstocked because the present stocking level is too heavy to allow the stand to grow to merchantable size without a pre-merchantable thinning. The "average acre" consists of 200 trees approximately 20 years old, four inches diameter at breast height (d. b. h.) and spaced 14 feet apart.

The overall quality of the growing stock is unusually good; especially when the site limitations are considered.

Priority area II, consists of a long, narrow five-acre tract with an eastern aspect. This area shows more surface rock and runs approximately 15% more slope than priority area I. Stocking consists primarily of American elm and hackberry. Associated species run about the same as for priority area I except for the deletion of red mulberry and box elder and the addition of chinquapin and black oak. Associated species, as a whole, are scattered.

Stocking of desirable species is very poor over the entire area, resulting from the heavy mortality of American elm infested with the Dutch elm disease. Many elms yet survive but will undoubtedly succumb to the disease within the next few years, leaving only scattered hackberry as the residual overstory.

The quality of the growing stock hackberry ranges from fair to good; the overall condition is fair. Priority area II is not of sufficient site quality as to warrant any intensive timber management strictly as an investment for timber production. However, woody vegetation is the best cover the area can afford.

Management prescription by area:

Priority area I has two square acre plots established side by side. The south plot is designated as a control and will not receive any cultural practices whatsoever. The north plot will receive the same cultural practices as the rest of priority area I.

An orange spot, at eye level, has been painted on the north face of potential crop trees in the north plot. The remainder of priority area I will be likewise marked with the exception of the south control plot. All trees not so marked with orange paint will be killed.

Natural reproduction from seed should be noticeable within five years following the reproduction cut. Prune and de-vine as needed on crop trees.

Priority area II, because of its poor site quality and species composition, is suitable only for hackberry. Management practices to increase the production of hackberry timber include

all of the timber stand improvement recommendations.

Underplanting with hackberry seedlings is essential to bring the stocking level up to permit economical feasibility in the management of this area for timber. The returns for management will be much lower on this area than priority area I. However, everything considered, such as benefit to wildlife and increased recreation potential, timber management would be worthwhile.

Timber Stand Improvement Recommendations

Timber stand improvement work is best accomplished in the late fall or winter. The only exception is planting, which should be done after danger of hard freezing is over.

Weeding and thinning: Competing trees can be cut or killed. In either case herbicides should be used to insure complete kill, thus preventing sprout growth. In applying herbicide to the cut stump use a mixture of one gallon (4 pound acid)2, 4, 5-T in 25 gallons of diesel fuel. Apply generously to the point of runoff, on the freshly cut surface. (Otherwise the wood vessels collapse in drying and provide a protective barrier against the herbicide.) Presently, 2, 4, 5-T is under study to determine safe tolerance levels. At the time of this writing, it is not restricted from this use. Naturally, all labeled precautions should be adhered to.

Trees can be killed by axe frilling with single overlapping hack marks around the tree, followed by an application of the herbicide. The nearer the application is made to the base of the tree the more sure the results.

Another way, similar to the axe frilling method, is to use a narrow bit hatchet (shingle hatchet preferred) and make hacks spaced one to three inches apart, three to six inches from the ground line, around the tree.

Then apply undiluted 2, 4-D Amine (not under restriction at present) at the rate of 1/4 teaspoon per hack. Walnut, hickory, large American elm, mulberry, dogwood, and redbud require one-inch spacing; other trees three inches.

Vine removal: Climbing vines compete with the tree, especially for sunlight, and should be removed. Smaller vines can be pulled

off the trees, but larger vines must be cut and a herbicide applied to the lower cut to prevent sprouting. The herbicide can be painted on the cut. But care should be taken to avoid spilling any on the tree. Some wild grape should be left as they are a source of food for wildlife.

Pruning: Pruning improves the quality of the tree when harvested. It is most effective on trees four to ten inches in diameter. Branches should be pruned before they exceed two inches in diameter or the wound may not heal properly.

Prune trees, if possible, during the fall and winter, because spring pruning may result in excessive sap bleeding. Prune to obtain at least an eight-foot clear log. However, it is best to prune to a height to obtain the longest clear log practical. No more than one-third of the living crown should be removed at one time and a crown of approximately one-half of the tree height should be maintained for proper growth.

Underplanting: In the spring the existing openings and openings created by harvest and cull removal should be planted with walnut or hackberry seedlings.

Spacing of the walnut can vary, but a two by two foot spacing (75 trees per acre rate) would assure good stocking. Don't plant under the crown of adjacent established crop trees since even young trees need sunlight.

Site preparation and weed control are essential for seedling survival and fast growth. Clear away all grass, weeds, leaves, and other litter down to mineral soil from an area about five to six feet in diameter where the seedling will be planted. A heavy garden rake will suffice. A pre-emergence herbicide, Simazine, should be used. Refer to the table for calibrating knapsack sprayer.

Seedlings can be purchased through the Kansas State University Extension tree distribution program at a nominal cost. Place orders with the Jefferson County agricultural extension agent during January or February.

Overstory removal: Several years after planting or whenever the walnut seedlings are well established, the undesirable overstory trees can be poisoned to die standing. This provides

a gradual release and gives the walnut a good start over undesirable competition that results naturally from opening up the stand.

Of course the undesirable overstory trees can also be felled and the stumps treated with herbicide and oil mixture but damage to the growing stock is usually severe.

Schedule of Future Harvest Cuts

Priority area I: The average growth rate on the dominant and co-dominant walnut poles is one inch of diameter in 2.4 years. Assuming the continuation of the present rate of growth, the schedule of harvest cuts for the one-acre north plot is as follows:

Year	Type of Cut	No. Trees	Volume Harvested Bd. Ft.	Cords	Value At Harvest	Value 1970
1970	Intermediate	151	---	2	4	4
1993	Intermediate	20	1,040	1	266	70
2000	Intermediate	20	2,140	2	818	142
2012	Intermediate	15	3,660	4	2,534	219
2019	Reproduction	25	8,850	9	8,813	507
	Totals	231	15,690	18	$12,435	$942

After timber stand improvement is completed this plot will have 80 sapling to pole size walnut trees averaging 5.59 inches d.b.h. and spaced 23.33 feet apart on the average.

Volume harvested is based on the assumption that trees will yield ten foot prime butt log and eight foot common second log.

It is unlikely that the one inch of diameter in 2.4 years rate of growth will continue on this site unless the trees are fertilized. Since research hasn't yet developed fertilizer data to date, the one acre projection will also be made on a one inch of diameter in 4 years rate of growth. This data is as follows with present value discounted at 6% compound interest:

Year	Type of Cut	No. Trees	Volume Harvested Bd. Ft.	Cords	Value At Harvest	1970
1970	Intermediate	151	---	2	4	4
2008	Intermediate	20	1,040	1	266	29
2020	Intermediate	20	2,140	2	818	44
2040	Intermediate	15	3,660	4	2,534	43
2052	Reproduction	25	8,850	9	8,813	75
	Totals	231	15,690	18	$12,435	$195

The total volume produced in the second table correlates closely to nationally accepted data for areas of comparable site quality without fertilization. Therefore, the projection in the second table should be considered as highly probable. The projection in the first table, to be considered only if proper fertilizer techniques will be available and applied within the next 10 to 15 years, is probable, taking into account the present research effort.

WINDBREAK

A windbreak will be planted on the north side of the buildings to afford protection.

Early soil preparation is highly important to tree survival and growth. Clean up the site the year prior to planting. Deep plow the area during the fall preceding planting.

Take care of tree seedlings immediately upon arrival. If possible, plant at once. If planting must be delayed, put the box in a cool but frostproof cellar and moisten the roots. Trees can be held for several days this way.

If it is necessary to hold the trees more than two or three days, unpack them and heel them in the garden. Prepare a shallow trench and cover the roots with fresh moist soil. Tamp securely to force out any air pockets, then water thoroughly.

Place the trees in a pail or tub of water to be carried during the planting operation. Be sure the roots are kept moist. DO NOT allow them to become dry at any time.

Plant in a hole deep enough so roots are not crowded, twisted, or turned up at the tips. Plant the seedlings at the same depth as they were in the nursery beds. Pine should never be planted deeper than they were in nursery beds. If a planting machine is used, have someone follow it to check each seedling for proper planting.

Dry soil, trash, or clods should not be in direct contact with the roots. If the soil is dry at planting time, fill the hole around the seedling about half full of soil, finish filling the hole with water, then complete filling the hole with soil. Do not plant in hot, dry soil. Irrigate or water seedlings if possible.

Be sure the soil is packed solidly around the roots so no air pockets are present to allow the fine root hairs to dry out. Mulch the area around the newly-planted seedling to prevent cracking and baking the surface.

For additional details on tree handling and planting refer to Extension Service leaflet L-72, Tree Planting Guide. For species selection, spacing, and arrangement refer to the sketch at the end of the windbreak section.

Sketch of Windbreak

200 feet	600 feet
Austrian pine, 10 feet apart	Cotoneaster, 4 feet apart
Russian olive, 12 feet apart	Eastern redcedar, 8 feet apart
	Eastern redcedar, 8 feet apart (staggered)
Headquarters Area	Austrian pine, 10 feet apart
	Russian olive, 10 feet apart (staggered)

Total amount needed: 12 feet between rows

Eastern redcedar	150
Austrian pine	100
Russian olive	100
Cotoneaster	150

Timely maintenance is the final key to a successful planting. The windbreak must be tended like any other crop to control weeds, rodents, and insect pests.

No single factor in management is more important to tree survival and growth. There are two basic methods for weed control.

Cultivation can be done with a variety of ordinary farm equipment. A one- or two-row cultivator is ideal to straddle the rows the first year. A tandem disk or spring-tooth cultivator will do a good job between rows. In either case cultivate shallow, 3 to 4 inches at most, to avoid injury to tree roots. Some handwork is usually necessary to eliminate weeds at the base of each tree. Continue to cultivate until trees close sufficiently to shade the ground.

Chemical weed control may be the answer to the weed problem, particularly in the rows. The pre-emergent herbicide Simazine has given good results on annual weeds and grasses at application rates of two to four pounds of actual material per acre.

A rate of three pounds per acre of an 80 percent wettable powder should be applied in a 3- to 4-foot band down the row before weed seeds germinate. The soil surface should be smooth and free of weeds at time of application. Manufacturer's recommendations must be followed to avoid damaging trees. Consult the county agricultural agent for additional details.

Protect all plantings from livestock, regardless of the age of the planting. Livestock, if allowed in the windbreak, will trample and pack the soil, break or eat small trees, and damage lower limbs of large trees.

Control rabbit damage by use of wire screens, wraps, poisoning, trapping, and repellents. Don't depend completely on a repellent if there is a critical shortage of browse.

Check the windbreak frequently throughout the growing season for disease or replacement needs.

Water the windbreak if at all possible. Soak the soil thoroughly. Fall soaking, just before freeze-up, is very helpful for evergreens.

Avoid pruning the windbreak, except to remove dead or diseased branches. Pruning reduces density and therefore lowers the capacity of the windbreak to stop wind and snow.

CHRISTMAS TREE PRODUCTION

Native grown Christmas trees are becoming popular in Kansas with both producers and consumers.

Proper management of the trees, including shearing and shaping, improves quality. Some trees will be left as controls to demonstrate the results of cultural work. The Christmas tree demonstration will magnify, because of shorter rotation, the basic principles being demonstrated in the woodland management area.

The pine species, which make the most desirable Christmas trees, are well adapted to local growing conditions. Pine will grow under a variety of soil and weather conditions and will survive under long periods of moisture deficiency. Pines have a desirable color and appearance, are easy to decorate. After cutting they retain their needles over a long period. Pines grow faster than most evergreens and are ready for harvest in five to eight years.

Three species commonly planted in Kansas are: Scotch pine, Austrian pine, and white pine. The Scotch pine seems to be the best seller and are preferred by most growers. However, for purposes of demonstration, plant 50% Scotch, 25% Austrian, and 25% white pine.

Tree seedlings can be purchased from commercial nurseries or ordered through the county extension agent's office or the soil conservation district office.

Planting stock should be 6 to 12 inches in height, and of age classes of 2-0, 2-1, or 2-2. The first number in age class refers to the number of years the tree grew in the seedbed and the second number to the number of years in a transplant bed. A 2-2 tree grew two years in the seedbed, was transplanted, and then grew two years in the transplant bed.

Plant 200 trees annually as an addition, for six or seven years. Then plant only replacement trees.

Soil preparation is essential for good survival and growth. The area to be planted should be plowed the preceding fall.

A newly planted tree grows very slowly until its roots are well established. After the second or third year, growth speeds up and the tree develops a long slender leader. Continued rapid growth produces an open spindly tree with sparse foliage and too much space between whorls of branches.

Shaping and shearing will improve the quality of all trees in a plantation and increase their value. This process also reduces the number of cull trees produced. The shearing of pine trees is done in the spring when the new growth (candles) is still soft and succulent, but after they have practically completed their elongation and before the new growth hardens. At this stage, new buds are well-formed but tender. A good rule of thumb is to shear just when the needle facicles reach an even spacing all along the terminal leader but before the growth hardens. This period will vary somewhat but usually between June 15 and July 15. Too early shearing will result in a too profuse bud set and irregular growth. Pruning too late (after the wood is hardened) will result in few buds, slow growth, and dead stubs. In most plantations there will be a period of about 15 days when conditions are ideal for shearing.

Start by cutting the leader to desired length (12 to 14 inches is best). Then clip the laterals of the terminal whorl so that they are three to five inches shorter than the terminal. Next proceed around the tree and clip all laterals so as to shape the tree into an inverted cone.

On the second and third shearing, proceed in the same manner but take more care to select and insure a main terminal leader. Closely sheared trees do not sell as well as ones with some growth on them. Allow all trees to grow out for one growing season after shearing before you market them.

Austrian pine usually does not need to be shorn as heavily as Scotch and white pine. For good results, just nip the tips of the new growth on these species.

It will be several years before Kansas grown trees supply more than 10 percent of the Christmas tree market. There will probably always be some competition from shipped-in trees. The consumer will pay more for a quality plantation grown tree, so grade the trees and price according to quality and grade. Consultive service will be available when trees reach marketable age.

ARBORETUM

An arboretum will be established at the outdoor laboratory. Aside from its inherent beauty aspects, the arboretum offers an ideal place for dendrology studies. It would serve as a model for growth comparison between species too.

The area to be planted will be plowed in the fall to prepare the site. A small area will be reserved as a nursery for growing seedlings from seed and for transplanting of seedlings received prior to final planting. The soil in the nursery bed area should be built up with organic matter, sand, and nutrients according to soil test analysis and current nursery recommendations. A sun shade will be constructed using common snow fencing. Irrigation facilities will be necessary for drought periods.

Species selection and arrangement: The following list suggests species to be included in the arboretum.

Black maple	Acer nigrum
Silver maple	Acer sacharinum
Sugar maple	Acer sacharum
Buckeye	Aesculus glabra
Tree of heaven	Ailanthus altissima
Serviceberry	Amelanchier arborea
Paw paw	Asimina triloba
Shagbark hickory	Carya ovata
Pignut hickory	Carya ovalis
Catalpa	Catalpa catalpa
Hackberry	Celtis laevigata
Dogwood	Cornus drummondi
Persimmon	Diospyros virginiana
Russian olive	Elaeagnus angustifolia
Green ash	Fraxinus pennsylvanica

Kentucky coffeetree	Gymnocladus dioica
Walnut	Juglans nigra
Mulberry	Morus rubra
Sycamore	Platanus occidentalis
Cottonwood	Populus deltoides
American plum	Prunus americana
Crabapple	Pyrus malus
White oak	Overcus alba
Bur oak	Overcus macrocarpa
Chinquapin oak	Overcus acuminata
Pin oak	Overcus palustris

The various species within the arboretum can be arranged in a number of ways. For example: All species of one genera can be located in one section of the arboretum. It is more important, however, that trees having the same sunlight, water, soil, and nutrient needs be grouped together to ease maintenance.

Procurement: Student groups may be interested in assuming some of this task. Others to approach would be faculty, conservation clubs, and civic organizations.

By planting extras of different species in the nursery, trading stock will be built up and many exotic, as well as hard to obtain local plants, can be readily procured. It would serve no good purpose to retain extras for trading in species that are readily available and not in demand.

By joining the American Association of Botanical Gardens and Arboretums, and similar groups, listings of trading stock, wanted and for trade, are maintained.

Maintenance: A pesticide spray schedule should be designed to meet the needs of the various species. The water and nutrient requirements of different species should be correlated to a schedule of care.

WOODLAND GLOSSARY

Arboretum--A place where trees from various localities throughout a wide region are propagated and grown, as individuals or in small stands, for scientific or educational purposes.

Aspect--The direction toward which a slope faces.

Associated species--An assembly of woody plants having ecologically similar requirements.

Bud set--A term referring to the number and quality of buds becoming established.

Clear log--A log free of all blemishes or defects.

Common--A log grade indicating a yield of lumber only.

Competing trees--Undesirable growing stock trees that compete with desirable growing stock for sunlight, moisture, and/or nutrients.

Composition--The relative proportions of the various species included in the total cover of a given area.

Control--An area affording a standard of comparison or means of verification; a check.

Crop trees--The growing stock designated to remain in the stand until harvested as mature timber.

Crown--The branches and foliage of a tree.

Culture--The physical application of technical forestry principles to the operation of a forest.

D. B. H. --The diameter of a tree at 4.5 feet above average ground level.

Dendrology--The identification and systematic classification of trees.

Desirable species--Those species considered to yield the greatest return to management efforts.

De-vine--The process of removing competitive vines.

Ecology--The science which deals with the relation of plants and animals to their environment and to the site factors that operate in controlling their distribution and growth.

Face--One-fourth of the circumference of a log for its entire length.

Frilling--A single line of overlapping downward axe cuts, leaving a frill into which toxic materials may be poured.

Genera--Closely related group of species.

Gradual release--A gradual opening of the stand to sunlight.

Growing stock--The sum (in number or volume) of all the trees in a forest.

Herbicide--A chemical pesticide used to kill undesirable plant life. Many herbicides are selective in that they will affect only a certain type of vegetation.

Intensive timber management--The intensive application of business methods and technical forestry principles to the operation of a forest property.

Laterals--Side branches.

Leader--The terminal shoot of the main stem.

Multiplier effect--The amount of additional income which accrues to the economy of Kansas as a result of the stumpage value of walnut timber.

Needle fascicles--The bundle sheath at the base of the needles.

Organic matter--Decomposed plant tissue.

Overstocked--A condition of stand or forest indicating more trees than normal or full stocking would require.

Pole--A young tree between 4 and 12 inches in diameter breast high.

Pre-emergence herbicide--A herbicide applied prior to the emergence of plants germinating from seed for their control.

Primary species--The most important species from the timber production standpoint.

Prime--A log grade indicating a yield of top quality veneer.

Prune--To remove live or dead branches from standing trees. This may be done artificially or naturally.

Reproduction cut--An intermediate cut made to open up the stand to allow natural reproduction.

Residual overstory--The remaining trees in the upper canopy-level of the stand.

Rotation--The period of years required to establish and grow timber crops to a specified condition of maturity.

Sap bleeding--The exuding of tree fluids.

Sapling--A young tree between two and four inches in diameter breast high.

Sawtimber--All trees 12 inches d. b. h. and larger.

Secondary associated species--Relatively unimportant timber species within a stand.

Seedling--A tree grown from seed. Usually the term is restricted to trees smaller than saplings (less than two inches in diameter breast high).

Shaping--The overall operation of shearing and pruning.

Shearing--The process of clipping the tips of the branches. This makes for more buds, thus increasing the number of branches and improving the density of foliage.

Siltation--The process of eroded soil particles being deposited.

Site--An area, considered as to its ecological factors, with reference to capacity to produce forests or other vegetation.

Stocking--An indication of the number of trees in a stand as compared to the desirable number for best growth and management.

Stumpage value--The value of timber as it stands uncut in the woods.

Timber stands--An aggregation of trees occupying a specific area and sufficiently uniform in composition, age arrangement, and condition as to be distinguishable from the forest growth on adjoining areas.

2,4-D Amine--A herbicide of the phenoxy group that is nonvolatile and is effective on most species of broad-leaf plants.

Underplanting--Setting out young trees or sowing seed under an existing stand.

Understocked--A condition of stand or forest in which the growing space is not effectively occupied by crop trees.

Upland--Land elevated above the alluvial bottomland.

Whorl--When two or more leaves or branches are found at the same node, they are referred to as whorled or verticillate.

Wildfire--An uncontrolled fire from any cause.

Wood vessel--A vertical series of cells that have coalesced and formed an articulated, tubelike structure of undeterminate length, and whose pits to congeneric elements are bordered.

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U.S.D.#345
purchase with
E.S.E.A. Title III Funds

For an outdoor laboratory to serve multiple purposes and provide maximum opportunity for learning about the environment, reasonable management of both the land and the people using it is necessary to maintain habitats suitable for biological studies.

Part of the total area is "left alone" to follow a natural course of succession. In other areas, especially those having native grasses, mowing for control of brush aims to maintain a prairie habitat.

Some woodland (Field 8) is left in its natural condition; dead trees are left standing, and fallen limbs or trees will not be removed except on trails. Other woodland areas of native trees (Field 7), the Christmas tree plot and arboretum, are managed.

Although campfires are allowed in one heavy-use area, firewood must be brought in or gathered only off the ground in specified woodland areas. Care is taken to maintain natural woodland edge, bordering grassland or other managed plots, because of its value to numerous species of birds and other animals.

Trails provide learning opportunities without the need of skilled interpreters, and minimize damage to the habitat by persons wandering at random. Refer to the environmental project section for nature trail establishment. A booklet, Trail Planning and Layout, is available from the National Audubon Society Nature Centers Division, 1130 Fifth Avenue, New York, New York 10028. This booklet is one in a series on "Nature Centers and Outdoor Education Areas."

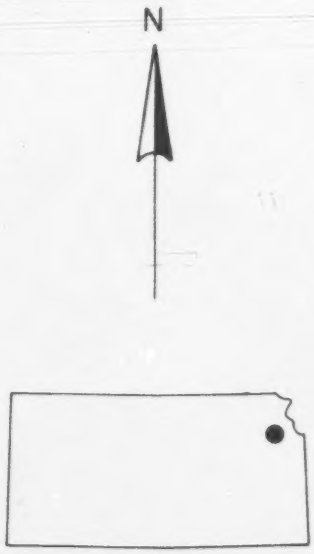
Students using the area should recognize their obligation to take proper care of it, minimizing their disturbance of habitats. Rocks or logs that are lifted in searching for animals must be returned to their former positions. No collecting of animals and plants is permitted except as authorized by instructors for teaching and research purposes.

Some precautions should be observed. A few venomous species occur in the area. No attempt should be made to eliminate these

animals, because they are a desirable part of the fauna; bu. all users should be alert to a possible danger. Use by individual youngsters, alone, is discouraged unless they are well informed in safety measures. Capturing and handling cooperheads or other poisonous species, without definite purpose, is foolish and is not permitted.

U. S. DEPARTMENT OF AGRICULTURE

BIOLOGY MAP

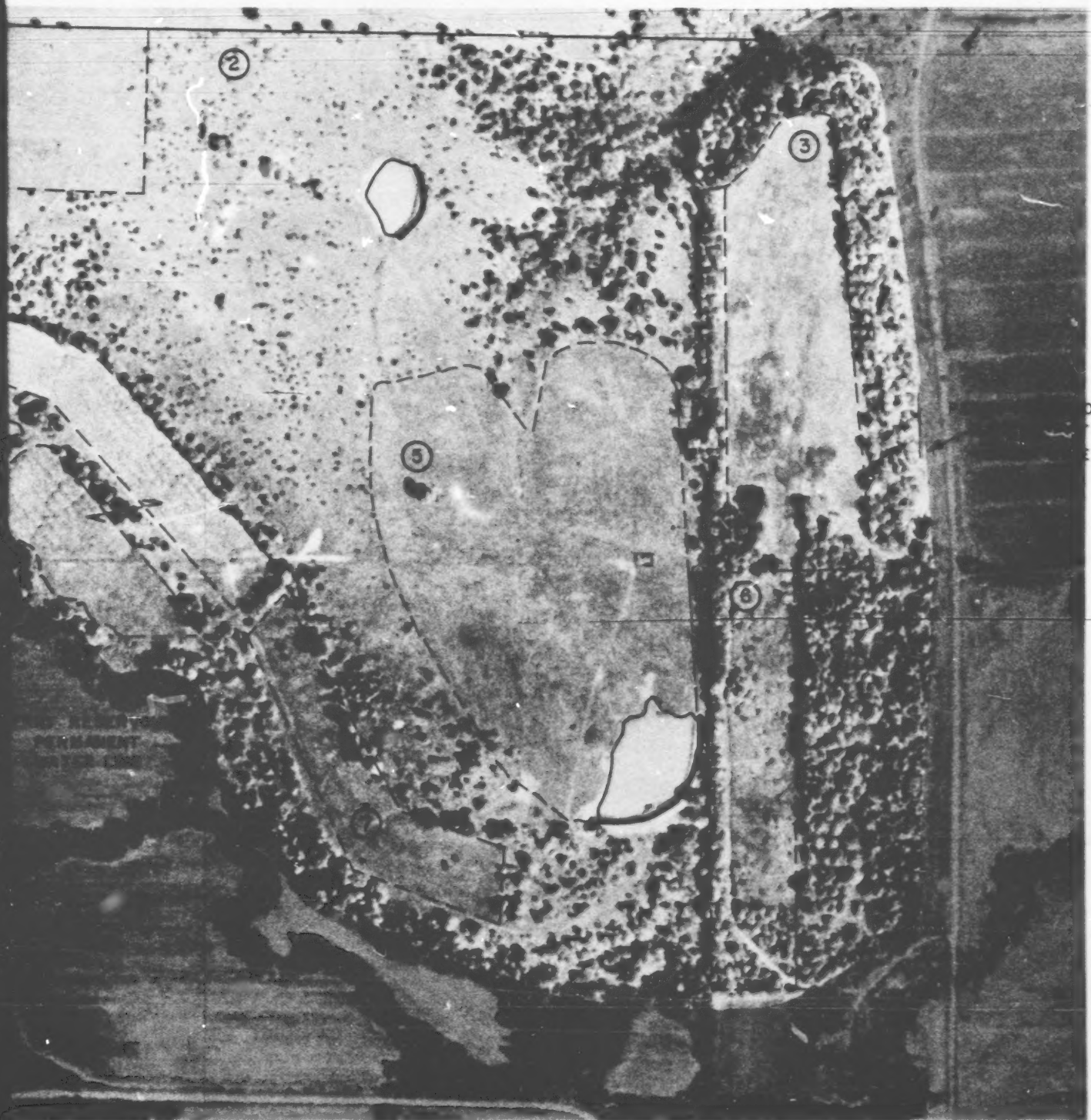


SCALE 660

USDA SCS LINCOLN, NEBR. 1970

SOIL CONSERVATION SERVICE

BIOLOGY MAP



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APPROXIMATE

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BIOLOGY RESEARCH PROJECTS

Research projects involving small classes or pairs of students are encouraged. Some projects suitable for this area are:

1. Measurements of population density and fluctuations in numbers of small mammals, insects, or other invertebrates, and plants in sample plots, on a seasonal or year-to-year basis.

2. Relationships of vegetative cover to slope, soil-type, and moisture.

3. Comparisons of animal populations between different habitat types, generally dependent on vegetative cover.

4. Censuses of nesting birds.

5. Comparisons of plants and animals found in two ponds with those found on the shore of Perry Reservoir.

6. Comparisons of physico-chemical conditions in these three aquatic environments (temperatures, turbidity, mineral content, wave action, bank erosion, and fluctuation of water level and its effects).

In all such studies consistent methods and carefully written, detailed records (field notes) are vitally important so that data can be gathered over a period of years and meaningful comparisons can be made.

Using other sections of the plan, including the maps, excellent comparative studies can be made of the animals inhabiting different parts of the outdoor laboratory, and of changes in their abundance from year to year. Individual projects might compare the kinds and numbers of animals found in:

1. Natural woodland, part of field 8 versus managed woodland, field 7, Christmas tree plot; and field 3, arboretum.

2. Eroded areas versus those stabilized by permanent vegetation.

3. Cool season versus warm season grass plots, and in mixed native grass versus brome grass plots.

4. Different soil types (soil map).

5. Areas where different parent materials are exposed (see geology map).

In general, geologic formation, soil-type, and the history of land use determine the kind of vegetation on an area, and the vegetative cover determines the kinds of animals that use the area. The principal vegetative types are described elsewhere in this plan.

Detailed studies of the kinds and density of ground cover on specific fields are recommended; these can be made by random casting of a metal ring, or heavy wire formed to enclose one square meter, and carefully noting the kinds and number of individual plants within the space on which it falls. Where this method is impractical due to tall weeds or brush, comparable areas can be measured off for detailed inspection on the ground. Careful sampling procedures of this kind usually reveal remarkable differences from one spot to another, even in fields that appear uniform in vegetative type.

The amount and diversity of the vegetation regulates the kinds and numbers of animals that live in each place. Studies of the vegetation should accompany investigations of animal populations, if the latter are to be properly understood.

A few examples of studies that might be conducted on wildlife in the laboratory area, along with some standard methods and equipment needed, are described:

Censuses of small mammals to determine what species are present and their relative abundance can be carried out by systematically trapping an area by the grid method. A "standard grid" consists of traps placed at 50 feet intervals, ideally forming a 600 by 600 foot square having 144 trapping points or stations. Smaller, or differently-shaped grids, can be adapted to various fields on the outdoor laboratory area. Trap stations should be marked with stakes so that traps can be removed and returned to the same points repeatedly. Bait for traps may consist of mixed grain (scratch feed) or a mixture of rolled oats, peanut

butter, and bacon grease. Traps should be put in place and baited, but with treadle blocked, so as not to capture animals for five days. Then set and bait traps each day for 10 days of trapping. The purpose of the five-day preliminary period is to reduce bias in the results due to "trap habit" formed by some animals as they discover the bait. Repetition of trapping efforts at regular intervals would be desirable, for example, on approximately the same dates in spring, summer, and/or fall each year at the same trapping site. Therefore, corner stakes should be left permanently as an aid to reestablishing the grid.

Live traps and snap traps can be purchased from sources listed at the end of this section. Live traps also can be made from small cans, with a closure mechanism adapted from snap traps and hardware cloth. The Sherman trap is suggested.

In population studies using live traps, supplemental information on individual ranges of movement and in life-span can be obtained by marking the animals as they are captured. Methods of marking small mammals, such as toe-clipping, are described by R. D. Taber in Ecology, volume 37, pp. 681-685.

Snakes, lizards and some amphibians can be trapped by using a "drift-fence." The fence consists of a board or sheet metal about eight inches high and ten feet long or more, with glass jars having funnels of hardware cloth at each end. Construction and use of drift fences are described by Donald R. Clark in the Transactions of the Kansas Academy of Science, volume 69, No. 1, 1966. Lizards and amphibians may be marked by toe-clipping and snakes and lizards may be marked by clipping ventral scales or patches of scales in various combinations.

Pit traps are also useful for trapping small mammals, reptiles, and amphibians. These traps may be gallon cans or jars buried to the rim.

In all cases where traps are used they must be checked daily, early in the morning. Animals left in traps often die of exposure, or are eaten by carabid beetles, shrews, or other animals. A piece of cotton or other material may be placed in the trap to help in preventing mortality due to exposure. Care must be taken to insure that pit traps do not have water in the bottom.

Dates of observation of birds, and especially nesting records, should be kept, preferably in a card file. Important data that should be recorded for each nest include the species of the bird, location of nest, height from ground, kind of tree and whether the tree is alive or dead, distance from other nests, number of eggs or young, and, when possible, dates of egg laying and fledging of young. No birds, nest, or eggs should be collected without federal and state collecting permits.

In ponds on the laboratory site and in the surrounding reservoir, fish populations can be sampled by means of seines, preferably on a definite schedule. Seines 10 to 30 feet long, having a mesh size of one-eighth to one-fourth inch, are recommended. The net used and the kinds and numbers of fish caught should be recorded. Small fish, difficult to identify in the field, can be removed and preserved in a 10% solution of formaldehyde for later study, with less harm to their populations than in the case of birds, mammals, and reptiles. The two ponds differ in size and also in turbidity (muddiness) due in part to differences in vegetative cover on their watersheds. Therefore differences in their fish populations can be expected. Both will differ greatly from the reservoir bordering the laboratory area.

Useful data that might be obtained from fishes include: kinds present; their relative abundance, both by number and by weight; the age composition within the population of each species, ascertained by examining scales under moderate magnification; the length-weight relationship, and the "condition-factor" within different size groups of each species; and the kinds of food they utilize, based on examination of stomach contents of some specimens retained for that purpose. If samples of aquatic insects and plankton are obtained, the relationship of use to availability of potential food items can be determined; in that case, difference in the rate of digestion of different food items should be considered.

Standard equipment for obtaining samples of small bottom-dwelling organisms (benthos) and plankton can be purchased from sources listed in this section, as can equipment for determining various aspects of water quality (temperature, pH, oxygen content, and others).

VERTEBRATE INVENTORY

Vertebrates expected on or near the laboratory area are listed below. Records of specimens or sightings should be kept in the form of a cumulative list that indicates what animals actually occur there. The list of fishes includes data from seining the two ponds on the laboratory grounds and a tributary of the Delaware River in 1969, prior to impounding of water in the Perry Reservoir. Lists of reptiles, amphibians, and mammals indicate the habitats where each species is likely to be found. The list of birds includes the more common resident species; other species will be found during spring and fall migrations. The bird's status in northeastern Kansas is included.

FISH

Small Pond

Bluegill	Lepomis macrochirus
Green sunfish	Lepomis cyanellus
Largemouth bass	Micropterus salmoides

Large Pond

Black bullhead	Ictalurus melas
Carp	Cyprinus carpio
Channel catfish	Ictalurus punctatus
Golden shiner	Notemigonus crysoleucas
Green sunfish	Lepomis cyanellus
Largemouth bass	Micropterus salmoides
Red shiner	Notropis lutrensis

Big Slough Creek

Black bullhead	Ictalurus melas
Bluegill	Lepomis macrochirus
Bluntnose minnow	Pimephales notatus
Carp	Cyprinus carpio
Channel catfish	Ictalurus punctatus
Common sucker	Catostomus commersoni
Creek chub	Semotilus atromaculatus
Fathead minnow	Pimephales promelas
Golden shiner	Notemigonus crysoleucas

Green sunfish	Lepomis cyanellus	
Largemouth bass	Micropterus salmoides	
Orangespotted sunfish	Lepomis humilis	
Orangethroat darter	Etheostoma spectabile	
Red shiner	Notropis lutrensis	
Sand shiner	Notropis stramineus	
Stonecast	Noturus flavus	
Stoneroller	Campostoma anomalum	
Suckermouth minnow	Phenacobius mirabilis	

AMPHIBIANS

American toad	Bufo terrestris	woodland
Bullfrog	Rana catesbeiana	pond, lakeshore
Cricket frog	Acris crepitans	ponds
Chorus frog	Pseudacris nigrita	pond, lakeshore
Fowler's toad	Bufo woodhousei	grassland
Gray treefrog	Hyla versicolor	woodland, lakeshore
Great Plains narrow-mouth toad	Gastrophryne olivacea	woodland
Leopard frog	Rana pipiens	pond, lakeshore
Small-mouth salamander	Ambystoma texanum	moist soils, pond
Tiger salamander	Ambystoma tigrinum	moist soils, pond

REPTILES

Black rat snake	Elaphe obsoleta	woodland
Brown snake	Storeria dekayi	woodland
Bull snake	Pituophis melanoleucus	grassland
Common garter snake	Thamnophis sirtalis	throughout
Common water snake	Natrix spiedon	ponds
Copperhead	Agkistrodon contortrix	woodland
Eastern ringneck snake	Diadophis punctatus	open woodland
Flat-headed snake	Tantilla gracilis	grassland
Five-lined skink	Eumeces fasciatus	woodland
Great Plains rat snake	Elaphe guttata emoryi	woodland
Great Plains skink	Eumeces obsoletus	grassland
Ground skink	Scinella laterale	woodland
King snake	Lampropeltis getulus	moist woodland, grassland
Painted turtle	Pseudemys picta	ponds
Pond slider	Pseudemys scripta	ponds

Prairie king snake	Lampropeltis calligaster	grassland, woodland
Prairie skink	Eumeces septentrionalis	grassland
Racer	Coluber constrictor	throughout
Red milk snake	Lampropeltis triangulum	woodland, grassland
Six-lined racerunner	Cnemidophorus sexlineatus	grassland
Slender glass lizard	Ophisaurus attenuatus	grassland
Snapping turtle	Chelydra serpentina	ponds
Timber rattlesnake	Crotalus horridus	woodland
Western box turtle	Terrepene ornata	throughout
Worm snake	Carphophis amoenus	woodland

BIRDS

R-resident year-round, SR-summer resident, WR-winter resident

American goldfinch	Spinus tristus	R
Baltimore oriole	Icterus galbula	SR
Black-capped chickadee	Parus atricapillus	R
Blue jay	Cyanocitta cristata	R
Bobwhite	Colinus virginianus	R
Cardinal	Richmondena cardinalis	R
Catbird	Dumetella carolinensis	SR
Common crow	Corvus brachyrhynchos	R
Common grackle	Quiscalus quiscula	SR
Downy woodpecker	Dendrocopos pubescens	R
Eastern bluebird	Sialia sialis	R
Eastern kingbird	Tyrannus tyrannus	SR
Eastern meadowlark	Sturnella magna	R
Field sparrow	Spizella pusilla	SR
Great blue heron	Ardea herodias	SR
Great horned owl	Bubo virginianus	R
House wren	Troglodytes aedon	SR
Loggerhead shrike	Lanius ludovicianus	R
Marsh hawk	Circus cyaneus	R
Mourning dove	Zenaida macroura	R
Red-bellied woodpecker	Centurus carolina	R
Red-tailed hawk	Buteo jamaicensis	R
Robin	Turdus migratorius	SR, uncommon WR

Slate-colored junco	Junco hyemalis	WR
Starling	Sturnus vulgaris	R
Tree sparrow	Spizella pusilla	SR
Turkey vulture	Cathartes aura	SR
Yellow-billed cuckoo	Coccyzus americanus	SR
Yellow-shafted flicker	Colaptes auratus	R

MAMMALS

Coyote	Canis latrans	grassland
Eastern cottontail	Sylvilagus floridanus	grassland, brushy areas
Eastern mole	Scalopus aquaticus	woodland
Fox squirrel	Sciurus niger	woodland
Gray fox	Urocyon cinereoargenteus	woodland
Gray squirrel	Sciurus carolinensis	woodland
Hispid cotton rat	Sigmodon hispidus	grassland
Least shrew	Cryptotus parva	woodland
Long-tailed weasel	Mustella frenata	throughout
Meadow jumping mouse	Zapus hudsonius	woodland-grassland edge
Muskrat	Ondatra zibethicus	ponds, lakeshore
Opossum	Didelphis marsupialis	woodland
Plains harvest mouse	Reithrodontomys montanus	grassland
Plains pocket gopher	Geomys bursarius	grassland
Prairie vole	Microtus ochrogaster	grassland
Prairie white-footed mouse	Peromyscus maniculatus	grassland
Raccoon	Procyon lotor	woodland, ponds
Red fox	Vulpes fulva	woodland, grassland edge
Short-tailed shrew	Blarina brevicauda	woodland
Southern lemming mouse	Synaptomys cooperi	grassland
Spotted skunk	Spilogale putorius	woodland, brushy areas
Striped skunk	Mephitis mephitis	open woodland, grassland

Western harvest mouse	Reithrodontomys megalotus	grassland
White-tailed deer	Odocoileus virginiana	throughout
Woodchuck	Marmota monax	open woodland
Woodland white-footed mouse	Peromyscus leucopus	woodland

BIOLOGY GLOSSARY

Amphibian--Frogs, toads, newts, and salamanders (Class Amphibia). Most pass through a larval (tadpole) stage in which they have functional gills, after which they lose gills and breathe by lungs.

Aquatic environment--See environment.

Arboretum--A place where trees from various localities throughout a wide region are propagated and grown, as individuals or in small stands, for scientific or educational purposes.

Benthos--Small bottom-living organisms of streams, ponds, lakes, etc.

Collecting--Gathering specimens (plant or animal) for study.

Condition-factor--A measure of the physical condition or body-form of an animal (specifically fishes), determined by the following formula, where W is the weight in grams and L is the body length in millimeters: $K=\frac{W10^5}{L^3}$

Cool season grasses--Grasses that perform best when the temperature ranges between 42 and 90 degrees; bluegrass and bromegrass are the most common. Seed is produced prior to the hot season; dormancy follows until moisture and cool temperatures revive the plant.

Environment--A combination of all the external conditions and influences to which an organism is exposed; may be aquatic (underwater) or terrestial (on land).

Erosion--The group of processes whereby earthy or rock material is loosened or dissolved and transparted elsewhere.

Fauna--Animals; usually all the kinds that inhabit a specified area.

Fledging--Acquiring the feathers necessary for flight, and permanently leaving the nest.

Grid method--A method of systematically sampling an area by trapping or collecting at specific points (as explained in the text).

Habitat--The place where a plant or animal lives or the place where one would go to find it.

Insects--Any of a class of small animals with three clearly defined body regions (head, thorax and abdomen), three pairs of legs, and usually with wings.

Invertebrate--Includes all animals without a backbone or spinal column. Such groups as insects, spiders, snails, clams, and crayfish, as well as other groups are included.

Mammal--Any of the class of vertebrate animals which have the body usually covered with hair and nourish their young with milk.

Native grasses--An area covered with natural warm season grasses indigenous to the area. It has evolved into a plant community after a long period of being influenced by the environment of a site.

Oxygen content--The amount of oxygen in molecular form (02). In aquatic situations, measured in parts of oxygen per million parts of water (or in milligrams per liter).

Parent material--The horizon of weathered rock or partly weathered soil material from which soil has formed.

pH, reaction--The degree of acidity or alkalinity of a soil expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline.

Physico-chemical--Combination of physical and chemical properties as in a body of water. These properties may include temperature, turbidity, depth, mineral content, pH, oxygen content, etc.

Plankton--Floating or weakly swimming plants and animals whose movements are more or less dependent on currents. May be grouped into net plankton, those that may be caught in a fine meshed net; and nannoplankton, those too small to be caught in a net and must be extracted from water collected in a bottle.

Population density--Population size in relation to some unit of space. It is normally expressed as the number of individuals of a given kind per unit area or volume; for example, 200 deer mice per acre.

Prairie--A large land area on gently rolling or level land in the Mississippi Valley. The chief grasses are warm season native species. Big bluestem, little bluestem, indiangrass are the predominant species. Other species become important in the composition as the environment changes from dry to wet, from sands to clays, and from upland to lowland.

Reptile--Any of a class of air-breathing vertebrates including the alligators and crocodiles, lizards, snakes, and turtles. The body is usually covered with scales or horny plates.

Scale--Small, flattened, rigid plate forming part of the external body covering, especially of fish and reptiles.

Seine--A net with the top edge having floats and the bottom edge having sinkers, stretched between two poles and towed through the water for the purpose of catching fish and other aquatic organisms.

Snap trap--Any of a variety of sizes of traps such as the familiar mousetrap which has a metal bar that snaps over the animal, usually killing it.

Soil type--A subdivision of the soil series based on the differences in the texture of the surface layer. For example, Wabash silty clay. Wabash is the series name and silty clay is the type.

Species--A distinct kind of animal or plant.

Succession--The orderly process of community change. For example, if certain prairie areas are protected from fire, mowing or grazing, brushy plants will replace grasses and eventually the brush will be replaced by trees, depending on conditions such as amount of rainfall, type of soil, etc.

Trapping--A method of catching animals using a variety of devices such as snap traps, live traps, snares, etc.

Turbidity--Muddiness or cloudiness of liquids.

Venomous--Poisonous; having a gland for secretion of poisonous substance and capable of inflicting a poisonous bite, sting, or wound. The copperhead and rattlesnakes are venomous snakes.

Ventral--Pertaining to the lower surface or abdominal area of an animal. Opposite of dorsal.

Warm season grass--Grasses which grow most efficiently during the warmer months.

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SOURCES OF SUPPLIES

General research equipment: Forestry Suppliers Inc., Jackson, Mississippi.

Seines, net, etc.: Nichols Net and Twine, East St. Louis, Illinois. Nylon Net Company, Memphis, Tennessee.

Limnological equipment and chemicals: Wildlife Supply Company, Saginaw, Michigan. Hach Chemical Co., Ames, Iowa.

Traps for small mammals: H. B. Sherman, Box 683, DeLand, Florida. Animal Trap Company of America, Lititz, Pennsylvania.

ENVIRONMENTAL PROJECTS

A TEACHERS' PLANNING GUIDE TO OUTDOOR EXPERIENCES

Whatever the length and purposes of going outdoors, planning and thinking about the trip should precede and follow the experience.

1. Preparation of yourself

   a. What do you know about the children? Attention spans, previous experiences, controls needed by individuals and the group, the degree of planning the children can participate in, and skills needed in language arts.

   b. Mechanical concerns:

      Transportation, snacks, permission to go, permission to use facilities, clothing and equipment needed, people to contact, water and toilet facilities, routes to take, length of trip.

   c. What do you need to know regarding skills and content areas? What concepts will you try and develop?

2. Preparation of the children

   a. How will you introduce the proposed experience?

   b. What things are the children to plan and what things are already planned by you? Do the children understand their planning role?

   c. What knowledge do the children bring to the situation?

   d. What knowledge is lacking or in need of refinement?

   e. What are the children to learn? As a group? As individuals?

   f. How will they record their experience? Individual efforts, group recorders, picture taking, or various combinations of things mentioned?

g. How will behavior standards be developed for the trip? What will the standards be? Are there any "musts" from your point of view, particularly those of health and safety?

h. What other language arts can be woven into your plans? Interviewing, introductions, listening with a purpose?

3. The experience

a. In what ways will you insure that the children derive the greatest value from this experience?

b. How much talking and telling by you is necessary?

c. How many leading questions are you able to provide the children with so that they are more actively involved in looking, listening, and trying to analyze what they are experiencing first hand?

d. Are you trying to cover too much? Are too many concepts being presented?

e. Are too many skills being demanded of the children?

f. Are the children discovering the answers to those questions they established before coming on the trip?

g. Are the children seeing relationships between things - Example: When they see a bird, do they also listen for its call, see where it lives, and what it is doing?

h. Are they gathering evidence for possible later solution or identification, even though they don't know the answer now?

i. Are the children showing signs of needing a change of pace? What change do you think is indicated?

4. Evaluating the experience with children

a. What did we do?

b. What did we learn?

c. What big ideas (generalizations) did we learn?

d. What might we do differently next time?

e. What did we like about the trip; what didn't we like? Why?

f. How did we do in terms of the group's behavioral standards?

g. What new questions do you have as a result of the experience?

h. How can we make our experience a more permanent one? How might we share it with others?

5. Follow-up activities

a. What can the children talk about?

b. What can they write about? What kind of written expression will they use? Poetry, drama, imaginative stories, factual accounts, etc.

c. What pictural representations of their experience can they develop?

d. What symbolic interpretations can they make of their trip? How will they explain their symbolism to others so they can understand it?

Please note that the guide sheet is written in the form of questions rather than answers. You will need to find the answers to these and some unwritten questions. Educators for many years have stressed the importance of asking questions and having children seek the answers rather than the teachers telling the pupils what the answers are. This spirit of questioning and inquiry is emphasized in outdoor education. There are so many things to observe and ask questions about that the teacher obviously cannot know all the answers. However, she can learn to ask intelligent questions about the outdoors for children to answer. Of course, as the teacher learns more about the outdoors herself, she is better able to pose intelligent questions. However, a great reservoir of questions already exists in a class of elementary school

children. The teacher who utilizes the questioning nature of children is in an ideal position to assist children in the pursuit of understanding the world in which we all live.

THE FIELD TRIP

The field trip is one of the most exciting and fruitful learning experience in which children participate. It is an interesting and adventurous experience which can easily be related educationally to the total program of the classroom or to any specific subject area.

There is no need to fear the field trip as a difficult teaching situation. When proper pre-planning has been done, the teacher will feel comfortable and the children will respond with enthusiasm.

Neither is there need to feel that there isn't time for a field trip because "we can't get through the book if we take that much time away from school." The outdoors is the perfect experimental laboratory for activities in all subjects. Here there is school in a most enjoyable and informal setting.

Think of the field trip as an opportunity to walk out of the classroom and into a laboratory without walls, roof, or floor. It is a place where you are free to observe, to experiment with, and to prove to your own satisfaction things about which you have been reading.

This is a "classroom out-of-doors" where children can best be trained to use all their senses in interpreting the interesting things that they have long "looked at" but have never really seen. Focus on teaching children to increase their competence in looking and listening, in becoming sensitive to textures in nature, and in enjoying to the fullest the wonderful smells of the outdoors.

Teach about the common things and avoid the rarities. Remember that you have children of the same varied ability levels here that you had in your indoor classroom. Provide for all.

Keep children aware that the field trip is a lesson and never a lark. It is less formal than the classroom. But it is, nevertheless, an educational experience and not a picnic.

Decide the purpose of the trip and focus on this purpose as you plan with the children.

Decide upon certain important concepts that you want to illustrate, for example: (1) the dependence of man upon plants and animals;

(2) the formation of soil; (3) the preparation of living things for winter.

Remember that no detail is too small to deserve attention. One small detail overlooked could give the field trip a "black eye" in an entire school.

Don't plan too much in too short a time. Plan your trip as a preview of some new learning, or use it as a review of some learning about to be finished. You as a teacher need to know exactly what your responsibilities are in organizing a trip and what responsibilities are to be assumed by the administration. This will avoid misunderstandings and conflicts.

A field trip should be divided into three parts: (1) the preplanning; (2) the learning experiences on the trip; (3) the review and relearning which follow the trip.

A suggested guide for carrying these three steps through to completion is outlined below.

1. The pre-planning

    a. Purpose of the trip. Example:

        1. To teach respect for other people since so many people are involved--children, teachers, principals, cooks, bus driver, parents, etc.

        2. To teach respect for one's self by taking responsibility, by proper conduct, and by obeying safety rules.

        3. To teach respect for nature and the out-of-doors.

        4. To review what we learned last spring.

        5. To note changes that have taken place with the coming of summer.

    b. Respect for other people

        1. The principal. Be sure you clear the trip through the office before you talk to the children about the trip.

2. Your host.

   (a) Well in advance set date and time.

   (b) Give number in group and age.

   (c) Inquire about restroom facilities.

   (d) Become informed about any routines to follow.

   (e) Send questions to your guide in advance.

3. Parents.

   (a) Send home a mimeographed note telling where you are going and how, the purpose of the trip, when you will leave and return, and what clothes are appropriate.

   (b) Request that the note be signed and returned as a form of permit required before a child is permitted to go on the trip.

   (c) Ask parents to accompany you if you need them. Plan on one adult for every 8 or 10 children; know the parents well and brief them about the trip. They might like to take the tour in advance. Give them the names of all children in their care.

4. Cooks need to be notified if children will be late or will eat elsewhere.

5. Person arranging transportation should be contacted well in advance and notified immediately if there is any change in plans.

6. Bus driver.

   (a) Give her or him an opportunity to explain bus rules to the children. Ask about singing or other activities which may annoy the driver.

   (b) Appoint a child to thank the driver when the trip is over.

(c) Invite him to go as one of your group when stopping to visit a place of interest on the trip.

7. Teachers.

(a) Any special area teachers such as band, speech, or music teachers need to know of change in plans.

(b) If you have playground or other duty, make arrangements for someone to take your place.

(c) If you leave or return while school is in session, make no confusion. Some teacher may use your noise as an excuse not to take her children on a field trip. Besides, all your good teaching is wasted if children become rowdy on returning.

8. Handicapped children.

(a) Consider their welfare if they are taking the trip.

(b) Make arrangements for them if they aren't going without imposing on another teacher.

c. Respect of the student for himself

1. Each takes responsibility for his own behavior.

(a) Discuss behavior rules in advance.

(b) Know if food, cameras, radios, etc. are permitted. If so, each child carries his own - no loading these on the teacher.

(c) Go single file to board the bus and sit in assigned area.

(d) Observe bus cleanliness regarding gum chewing, candy wrappers, etc.

(e) Have two people appointed to check the bus floor for trash and to look for articles left on the bus at trip's end.

(f) Find out if the building will be open to get books, etc. when returning.

(g) Remember the reputation of your school depends on your behavior.

2. Know safety rules.

(a) Look out for poison ivy. "Leaflets three, let it be."

(b) Don't turn a large stone with bare hands. If you do turn a stone or log, turn it toward you because of possible dangers under it.

(c) Go to your teacher's first aid kit if you get a minor wound.

(d) Don't drink questionable water.

(e) Stay with your buddy at all times. "Two children are easier to find than one!"

(f) Keep head and arms inside bus.

(g) Leave windows as driver had them.

(h) Expect your teacher to take roll several times.

(i) On returning, if it is after school, remember to wait with your teacher until your parents come for you. If you are walking, go directly home.

d. Motivation - Some tangible objects to study before a trip is effective motivation. Children might be shown:

1. Soil layers prepared in a jar; topsoil, subsoil, shale, etc.

2. Two rocks of varying hardness or color.

3. Several kinds of leaves.

4. Insects for identification.

2. Experiences on the trip

a. Give to each child a mimeographed sheet listing things to watch for on the way.

b. Remind children that you are not a walking encyclopedia and besides, too much conversation is not good.

c. Take the lead, if you wish, but when talking walk back near the center of the group or have children form a semicircle around you.

d. Have children walk by twos usually except on a narrow path. Class officers or parents may bring up the rear to prevent stragglers from falling behind.

e. Don't answer individual questions while in motion. Some will miss the answer.

f. Sit if the leader is to talk at length to avoid pushing and noisy feet. The teacher and class are then a unit in an informal but familiar setting. There is no urging of stragglers either when all are sitting.

g. Make sure everyone sees what you are looking at. A beam of light from a pocket mirror might help to point out an object. The audubon nature bulletin also suggests verbal pointing--"at the left of the biggest rock,"--"15 feet beyond the patch of yellow flowers," --or "at ten o'clock in the biggest maple" (using a tree as the face of a clock).

h. Assign special jobs or observations to small groups of children so that everyone is participating. When on the trail, teach children to raise their hands when they see something unusual rather than to speak out. At this signal, the group can stop to see whatever they have discovered.

i. Don't just name things. Interpret what you see by calling attention to cause and effect, to reading the environment to learn what has happened here, "who" lives here, etc.

j. Stop occasionally for a quiet period and have children observe what their five senses can tell them in that particular spot. This could also be a time to see and talk about some specimens picked up on the field trip.

k. Point out an interesting landscape and ask children to study it so well that they can reproduce it later on paper as an art lesson.

l. Emphasize respect for nature:

1. By not hitting trees. A blow may start a fungus growth.

2. By leaving things undisturbed.

3. By building small check dams.

m. Plan at least one group activity and two individual activities. The group activity might be to look for accidents in nature as a fallen tree or a diseased plant. An individual activity might be for a child to count the animal homes he saw and to list the types of trees.

n. Above all, be enthusiastic! If you are thrilled at what you are doing and seeing, it will be contagious.

3. The follow-up and evaluation

a. Sit down and review the trip even before leaving the site if possible.

b. Discuss the trip as soon as possible after returning to school.

c. Talk about what we want to do next time.

d. Think about how the next trip can be an improvement over this one. What was bad? What was good?

e. Plan how you will express your new learnings by drama, art, writing, further research, sharing with other classes, murals, panel discussions, etc.

ENVIRONMENTAL PROJECTS

The following are lists of things to do and can be adapted to the particular class and grade level involved.

A. History Hikes and Classes

1. Visit old cemetery.
2. Visit nearby business.
3. Visit old bridge on road.
4. Visit farm site.
5. Visit water sources.

B. Forest and Prairie Hikes

1. Stream sedimentation.
2. Forestry procedures.
3. Forestry products.
4. Natural areas.
5. Soil formation.
6. Natural prairie.
7. Interdependence of plants.
8. Trail maintenance.
9. Use of keys (tree and flower).

C. Pioneer Study and Hikes

1. Genealogy.
2. Family as social unit.
3. Family names.
4. Health factors in pioneer home.
5. Social customs of time.
6. Historical Periods.
7. Indian life and effects.

D. Geology Study and Hikes

1. Rock classification.
2. Glacial study.
3. Erosion.
4. Recent geological activity.
5. Fossils.
6. Geological areas.
7. Rock collection.

E. Stream and Lake Hike and Study

1. Geographical terrain.
2. Plant and animal life.
3. Map making.
4. Compass skills.
5. Laying and following trails.
6. Estimating distance.
7. Contours and elevation.
8. Use of engineering measurement devices.

F. Estimating and Measuring

1. Distance.
2. Perimeter.
3. Height.
4. Area.
5. Diameter.
6. Stream flow.
7. Math formulas.

G. Fresh Water and Land Ecology

1. Community survey
2. Soil survey.
3. Interdependency.
4. Identification (plant and animal).
5. Seed dispersal
6. Growth rates.
7. Seed collection.
8. Leaf collecting.
9. Conservation practices.
10. Land uses.
11. Stages of development.
12. Balance of nature.

H. Simple Machines

1. Identification.
2. Actual use.
3. Technology.
4. Modifications and combinations.

I. Fire Building

1. Safety.
2. Elements.
3. Methods.
4. History of fire.

J. Conservation Projects

1. Build and check dams.
2. Plant trees.
3. Thin and trim trees.
4. Build bridges and steps.
5. Erosion control.
6. Trail maintenance.

K. Weather

1. Study and report.
2. Make forecasts.
3. Build stations.
4. Find averages.
5. Study effects and causes.

L. Astronomy

1. Use telescope.
2. Chronometers.
3. Constellations.
4. Space exploration.
5. Legends.
6. Star facts.
7. Navigation.

M. Arts and Crafts

1. Sketching.
2. Whittling.
3. Prints and casts.
4. Lapidary.
5. Pioneer games and crafts.
6. Nature's colors.

N. Evening activities

1. Barn dances.
2. Scavenger hunt.
3. Hayrides or sled.
4. Night hike.
5. Games.
6. Informal dramatics.
7. Star study.

O. Cookout

1. Plan menu.
2. Prepare meal.
3. Conservation and safety.
4. Fire use and control.
5. Etiquette outdoors.
6. Health standards.

P. Camp Log

1. Take notes.
2. Outline.
3. Prose and poetry.
4. Labels for displays.
5. Diary keeping.
6. Creative writing.

Q. Community Living

1. Cooperation
2. Respect for each other.
3. Responsibility (Individual and group).
4. Letter writing.
5. Health and sanitation.
6. Community services.
7. Mealtime manners and conversation.
8. Democratic principles.

R. Sports and Recreation and Camping

1. Pitch tents.
2. Obstacle course.
3. Riflery.
4. Fishing.
5. Boating.
6. Archery.
7. Canoeing.
8. Camp procedures.
9. Camp safety rules.
10. Survival.
11. First aid.
12. Father-son events.

S. Industrial Arts

1. Draw and design buildings.
2. Draw and design camp area.
3. Work with proper instruments.
4. Help construct facilities.
5. Draw and design boat docks.

NATURE TRAILS

One type of nature trail is concerned only with identification, not interpretation. Along such a trail, plants and other natural features are labeled with their common and scientific names and distinguishing characteristics. Such a trail serves the specific purpose of providing an opportunity for study by professional and amateur naturalists.

The miscellaneous or interpretive trail does more than the old type of nature trail. In addition to identifying specimens, it interprets a variety of features. There is a danger in tending to interpret the obvious, which often tells about subjects common to many places. This can become repetitious of other areas and disappointing to visitors who have previously walked similar trails.

It is recommended that the trail identify, interpret, and show relationships in the total environment.

An effective type of trail is one which tells a story or develops a theme. A story or theme gives a trail unity and coherence which help the visitor remember more of the interpretation. However, most trails of this type are associated with some unique feature of the area, either natural or man-made.

A question that arises when developing a nature trail is whether it should be self-guiding, guided, or both. There is no reason why it cannot be both. A trail used largely by classes, under the guidance of a teacher or some other interpreter, does not require an interpretive booklet or leaflet. The same trail can be interpreted through comprehensive signs, handouts, or even booklets, for those who wish to go it alone, or do not have the opportunity to go with a class or guide.

The advantage of a self-guiding trail is that it does not require the presence and expense of an interpreter. Visitors or students may walk the trail when they wish and at their own pace, and may receive as much or as little of the interpretation as they want.

Disadvantages of a self-guiding trail include the danger of running out of the interpretive leaflets, without which the average person would get little information along the trail. Careless discarding of leaflets may cause a litter problem. This problem is averted

when all interpretation is done through signs. Signs, however, when they get into much detail, become expensive, large, and difficult to construct.

On the kind of trail suggested here, it is well to have two types of signs: (1) labels, and (2) station signs. Labels are primarily for identification and may have on them only the common and scientific names of trees, shrubs, vines, wildflowers, and other plants. Labels are an important part of any nature trail and make it much more interesting for the professional user as well as the student.

Labels should be of a permanent type, plastic or metal strip markers (preferably aluminum) with embossed or raised letters. Those identifying trees may be fastened directly to the tree without injuring it.

Identification of annuals and perennials is recommended. For this, stakes can be used to hold either metal or plastic markers. These can be moved from year to year or during the season, if a plant dies or a better specimen is found. One need not be concerned about duplication, especially in identifying trees. It takes most students several exposures to really learn a species. This also serves to point out species variations and individual differences.

It is well to have an occasional covered label so the student can first try to identify the species, which he has seen earlier on the trail, and then lift the cover to see if he is correct.

The amount of labeling and exhibiting along trails should be limited and the methods used should be effective and unobtrusive. Good taste and good judgment are the best guides.

Station signs may also identify a species but usually carry more detail, point out something particularly significant, and are usually numbered. If there is a written guide for the trail, it is customarily keyed to these numbered stations.

Ideally, a nature trail has a series of stations plus interspersed, identified, and labeled specimens. If there is no accompanying written guide, station signs may have to be quite comprehensive. If a guide is usually present, he can elaborate on the significance of the station, and the sign can be correspondingly simple.

Interpretation on a self-guiding trail can be done entirely through the text on signs displayed at each chosen feature. This method is practical because it is fairly inexpensive and the rest of the interpretation is not disrupted when signs are changed, new ones added, or out-of-date signs removed. This flexibility is especially valuable when a trail is first being developed.

Whether or not to place a sign at a station depends largely on how many extraordinary features it is desirable to point out, how long the trail is, and how much time it is designed to consume. No trail should be cluttered with signs. All interpretive devices on a trail should be meaningful to the most inexperienced visitor. But these devices should not intrude too much into the scene.

Simplicity should be the key to such signs. Names, simple outline drawings, and diagrams for identification purposes are in order. Brief labels with short, concise language pointing out natural relationships are occasionally acceptable, but complicated relationships and fully developed ideas are best reserved for guide booklets or exhibits.

Entrance signs, directional signs, and other general information signs do not fall in this interpretive category. They usually evolve from necessity and are developed at the planner's discretion.

An excellent trail can be developed in half a mile, with 12 to 18 good stations, well interpreted, and significant species identified and properly labeled along the way.

Zoning may be employed in developing the trail so that greater emphasis can be given to distinctive features. This again depends on the length of the trail and the incidence of such features.

Such zoning may be confined to the main trail, or may incorporate side loops. Side attractions should bear such designations as geology loop, wildlife loop, soils loop, or pond habitat.

The area may be accessible enough so that separate trips can be made to study each zone. Some tours are divided into two parts or two trips; the first for identification of trees, other plants, and other things in the forest; and the second for ecology, or the discussion of basic interrelationships observable in the life of the forest.

Special areas: The cultivation of curiosity should be a prime purpose of the nature trail. This is enhanced by a trail which is both winding and secluded. Not being able to see what is around the next bend increases anticipation. It also makes it easier for the guide to keep attention focused on the subject at hand.

Interconnecting trails that allow a choice of walking time and study situations add variety and interest to an area.

The trail may lead through areas of special interest (erosion, plant succession, a burn), small enough to become stations.

On the other hand, such special areas may be extensive enough to be set aside for separate study. These separate areas should be separately identified and so indicated on the map, if there is one, and in the written guide. Certain special areas may be extensive or important enough to warrant their own writeup or booklet.

This points up the chief distinction between special areas and stations. Stations are stops in the main trail and are interpreted by special signs or by the printed guide. Special areas may call for their own trail, loop, or section of the main trail.

EXAMPLES OF SPECIAL AREA WRITEUPS

Demonstration plot: This one-fourth acre demonstration plot has been set aside to help you learn something about forestry and conservation in a practical way, and to help you understand the relationship between conservation and economics.

A forest is basically a collection of trees. It is a living community of plants and animals in which trees are the dominant species. Forests are among our greatest natural resources. They provide not only wood, but water, wildlife, forage, and recreation.

Wood is vital to our national security, our economic strength, and our well-being. More than 5,000 products in everyday use come from the forest.

Fortunately, forests are a renewable resource. That is, by applying the principles of good forestry we can use our forests and still always have them. This is wise management. If we are to have it - if we are to practice conservation - people must understand and be concerned about the forests, and develop proper attitudes and habits regarding them.

Since forests may be very large, we are taking a look at a small area. The center of this circular one-fourth acre plot is a steel stake your guide will show you. The perimeter of the circle is 59 feet away from the center.

This is a typical forest area for this region and elevation. Notice the kinds of trees we have here. Most of them are hardwoods (deciduous), but there are also some conifers (evergreens) present.

There has been no recent harvesting done on this plot, but by marking and identifying individual trees it is possible to show you something of how such a forest could be harvested and managed so that it will not only be improved but will always be growing here. In considering the management of a forest, one of the first things a forester must know is what does the owner wish to get out of this resource?

If the owner wants to convert the trees into all the money he can get immediately, of course, he would harvest them all at once.

If he wants to harvest only that which is produced each year, he can do this and still keep his growing stock, and his forest will always be there. This is known as cutting on a "sustained-yield" basis. Or, he can decide not to harvest any of the timber, but let the trees reproduce, grow, die, fall down, and decay as they will. This, of course, will produce nothing in the way of timber products. Death and decay will exactly offset growth; and, as in any virgin forest, the "annual increment" (annual growth or gain) is zero. It is true that the forest will still provide recreational and esthetic values and will protect the watershed. But, if all forests were closed to harvest, where would all the forest products we use come from?

Let us look then at what we may expect to get from this kind of forest if it is managed on a sustained-yield basis. Remember, such management will not interfere with the other benefits of the forest.

In harvesting, we would cut no trees smaller than 10 inches in diameter. We have numbered 22 such trees on this one-fourth acre. You will want to refer to the list of "commercial size" which also gives a description of each species.

There will be an average of 88 such trees per acre in this part of the forest. Their yield each year will be about one-half cord of wood, or approximately 250 board feet of lumber. (Note: Have a measured cord of wood and a measurable sawlog on or near the demonstration plot.) This much could be harvested each year on every acre in such a forest and the forest would still always be there. Also, by carefully selecting the trees to be cut and removing inferior and mature trees, the quality of the forest would be improved.

If all the merchantable trees on an acre such as this were harvested at once, they would yield about 40 cords or 10,000 to 15,000 board feet of lumber.

EXAMPLES OF STATIONS

Natural	Manmade
Fire damage	Fence wire imbedded in a tree
Animal damage (porcupine, sapsucker, bear)	Witness tree
Lightning tree	Bench mark
Decayed log or stump	Dump
Den tree	Hedge
Woodpecker nesting tree	Stone or rail fence
Unusually large tree	Dam
Unusual rock formation	Weir
Spring	Retaining wall
Small stream	Road cut
A lichen station	Borrow pit
An active burrow	Small pond
Bee tree	Tapped maple
Beaver work	Hacked pine (turpentine face)
Natural exposure soil profile	Bird bath
Gully	Feeding station
Fungus growth	Resting place (bench, council ring, etc.)
Uprotted tree	Footbridge
Unusual or large vine	Historical landmark
Natural reproduction	Picnic table
Hornet's nest	Evidence of logging activity
Squirrel nest	Sawlog
Glen or ravine	Cord of wood
Mound (may be manmade)	Measuring tree
Scenic view	Weather station

EXAMPLES OF SPECIAL AREAS

Natural	Manmade
Burn	Timber management
Geology	Timber sale
Wildlife habitat	Forestry demonstration plot
Lake	Silviculture
Stream	Timber harvest
Pond habitat	Farm woodlot management
Marsh	Recreation area
Swamp	Dam site
Desert	Game management area
Sagebrush habitat	Reservoir
Plant succession	Nursery
Soils	Plantation
Watershed study area	Maple sugar camp
Water hole	Logging camp
Tidal flats	Farm

EXAMPLES OF IDENTIFICATION WRITEUPS

Black walnut (Juglans nigra) is one of our most valuable trees. Its wood is in great demand for use in furniture, gunstocks, and interior finishings. Single trees have sold recently for as much as $1,000. They also bear delicious nuts. A fast growing hardwood, black walnut sometimes grows to be 150 feet high and 6 feet in diameter.

Virginia pine (Pinus virginiana) seldom grows over 50 feet high, and matures in 100 to 150 years. The needles are from one-half inch to three inches in length, and usually in pairs. The two-inch cones are reddish brown, shiny, and prickly, and grow tight to the stem. In recent years this species has become important for pulpwood. The wood is also used for lumber and fuel. Perhaps the tree's greatest value is in reforesting waste lands, for it seeds and does well in poor soil.

White ash (Fraxinus americana) is usually large and well shaped, and is one of the leading commercial hardwoods of the United States. The hard, close-grained, light brown wood is strong, tough, elastic, and free from taste or odor. It is most famous for its use in baseball bats and tool handles, but it is also used for oars, furniture, interior trim, boxes, railroad ties, veneer, and fuel. Clusters of paddle-shaped fruits one inch to two inches long often hang on the trees all winter.

Mayapple (Podophyllum peltatum) grows in colonies and sprouts from long, thick underground stems. It blooms the last half of May. The single, white, bell-shaped flower is often hidden under the broad leaves. The lemon-yellow fruit, when fully ripened in the summer, is edible but very laxative and should not be considered as food. All other parts of the plant are poisonous.

EXAMPLES OF STATION WRITEUPS

Fire damage: Note the large scar at the base of this tree. Foresters and loggers call this a "cat face." It was undoubtedly caused by fire many years ago. How do we know it was a long time ago? For one thing, there is no longer evidence of the blackened or charred area, which sometimes can be seen for years. Also, the tree has grown considerably since the damage was done.

Why did it not kill the tree? If the damage had gone all the way around the tree it probably would have killed it. The inner part of the trunk, which looks dead, is the heartwood. Actually, it is dead--in all trees. The heartwood, often much darker than the sapwood, is important to the tree in that it adds stiffness and support to the trunk. But a tree can live without it. You have undoubtedly seen completely hollow trees which are very much alive.

However, it is to the outside of the sapwood that the living layer of cells, called the cambium layer, adds growth every year.

Do you think this scar will be eventually completely covered? Perhaps. Or, the heartwood may rot out and the tree become hollow for the rest of its life. Then it would make a good home for animals. But it also lets in insects and disease. Such a tree is more easily blown down by the wind than a sound one.

And, of course, the damaged or rotted part is a waste if the tree is cut for lumber. This is one of the costs we often do not think of in connection with forest fire. While a fire may not kill a tree, it makes it much less valuable. And this happens to thousands of trees in a forest fire. So remember - be careful with fire!

Fence wire imbedded in a tree is another phenomenon involving the growth of a tree. No doubt many years ago some farmer fastened this fence wire to this tree conveniently growing at the edge of this field. This was one place he did not have to set a fence post, for he had a live one. Did it injur the tree? Not very much, although it did make it grow rough and warty. Why didn't the wire move up higher as the tree grew? We know the tree grew for many years and is still growing. It covered the wire and staples, until now they are in the very center of the

tree. Have you figured out why they are no higher off the ground than when the farmer put them there 30 or 40 years ago? Remember a tree trunk grows in diameter only. That is how it gets bigger around. The other place a tree grows is at the end of the twigs and branches. That is how it gets taller.

Bare-rock succession: The changing of biotic communities is called succession. This process is going on continually. One such succession may be seen here. It is a very important one. For this is one way our soils are formed, and our soils, of course, are the very foundation of life on earth.

The first community to appear on bare rock is some crustose lichen. The lichens, which next include successively, foliose and fruiticose lichens, produce acids that gradually make crevices in the rock surface. Small quantities of the decaying lechens and bits of dust, blown by the wind, collect in these crevices. Thus, a simple soil is formed and water no longer runs off so quickly. Mosses soon arrive, and seeds of larger plants germinate in the accumulating soil - grasses and other annuals, and eventually shrubs and trees. In many places, succession continues until a forest community develops, though the process may require hundreds of years.

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NATURAL AREAS

ALL NATURAL AREAS SHOULD REMAIN UNDISTURBED

ALTERATION OF SUCH AREAS SHOULD TAKE PLACE ONLY AFTER ADEQUATE STUDY AND EVALUATION

EACH AREA HAS IMMEDIATE VALUE AS A LABORATORY IN WHICH CHILDREN CAN OBSERVE STAGES OF SUCCESSION IN PLANT GROWTH AND ANIMAL POPULATIONS

WHAT IS THIS THING CALLED SUCCESSION ?

SUCCESSION IS THE NATURAL CHANGE THAT OCCURS IN VEGETATION OVER A PERIOD OF TIME AS VEGETATIVE TYPES CHANGE ANIMAL SPECIES ALSO CHANGE —

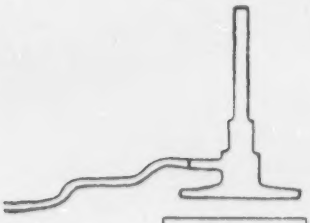
VARIOUS STAGES OF SUCCESSION MIGHT BE FOUND ON YOUR SCHOOL SITE !!

BUILD YOUR SCHOOLS TO FIT THE SITES

OPEN FIELD | SHRUB | FOREST | BARE GROUND

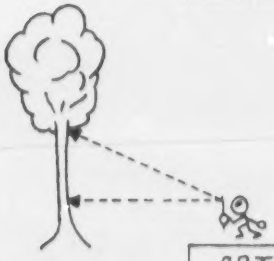
NATURAL WAYS TO USE NATURAL AREAS

SCIENCE



1. FOOD CHAINS
2. LIFE HISTORIES
3. PLANT AND ANIMAL SUCCESSION – ECOLOGY
4. SOIL AND WATER SCIENCE

MATH

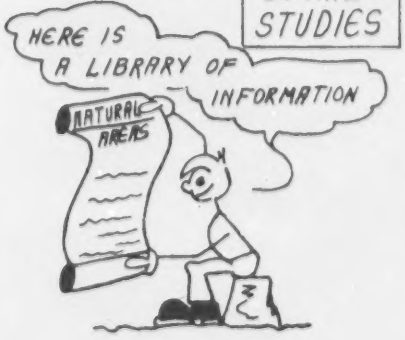


1. DETERMINING HEIGHT AND DIAMETER OF TREES
2. DETERMINING BOARD FEET OF LUMBER IN TREES
3. SAMPLING – RATIO
4. SURVEYING

ART

1. APPRECIATION FOR THE NATURAL SCENE
2. FALL COLORATION
3. DESIGN
4. SKETCHING

SOCIAL STUDIES



1. LOGGING IN MICHIGAN
2. LAND USE HISTORY – LAND DESCRIPTION
3. WATERSHED STUDY IN LAND USE
4. DRAINAGE SYSTEMS

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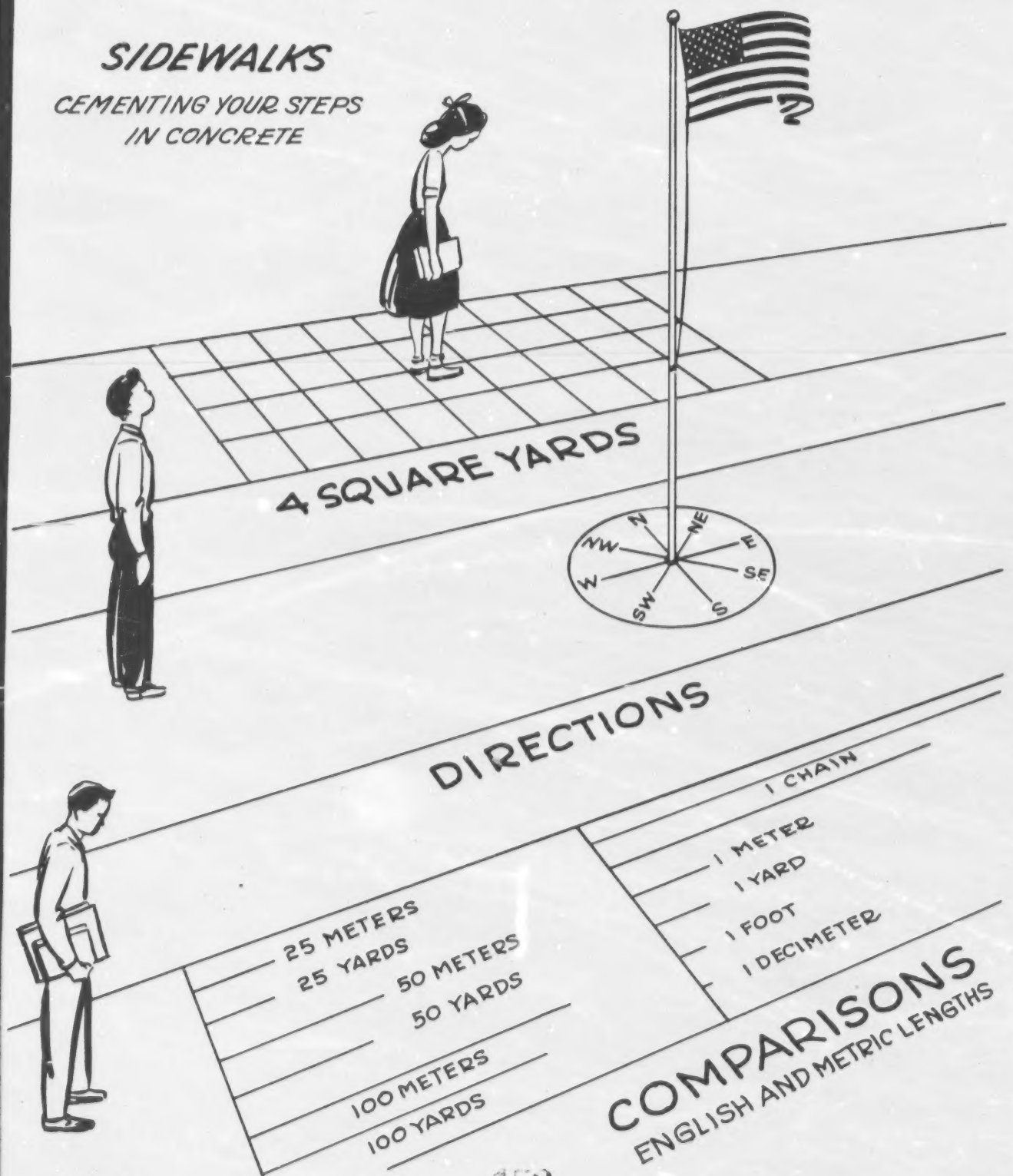
WEAVER , OUTDOOR LABORATORIES , INTERSTATE PRINTERS AND PUBLISHERS; DANVILLE, ILLINOIS

A WALK THROUGH LENGTHS, SHAPES, DIRECTIONS, AND MEASUREMENTS



MATHEMATICS-SCIENCE

USE OF SIDEWALKS, PARKING AREAS, DRIVEWAYS, BLACK TOP PLAY AREAS TO VISUALIZE SCIENCE AND MATHEMATICAL CONCEPTS.

MATHEMATICS

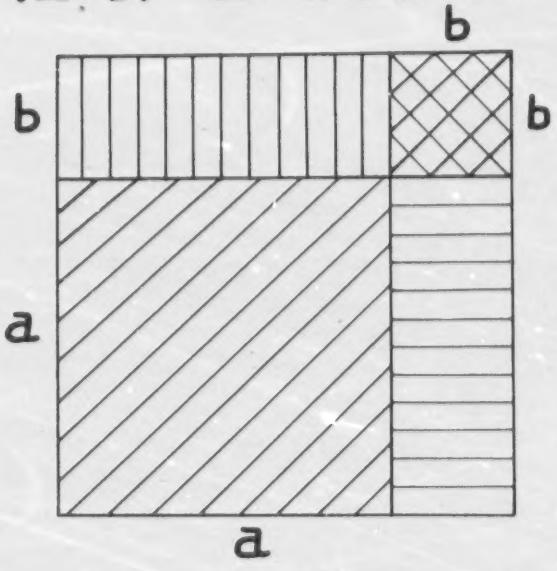
AREA MEASURE
LINEAR MEASURE
ALGEBRAIC EQUATIONS
ANGLES

SCIENCE

ASTRONOMY
WEATHER
LINEAR MEASURE
ANGLES

ALGEBRAIC EQUATIONS

$$(a+b)^2 = a^2 + 2ab + b^2$$

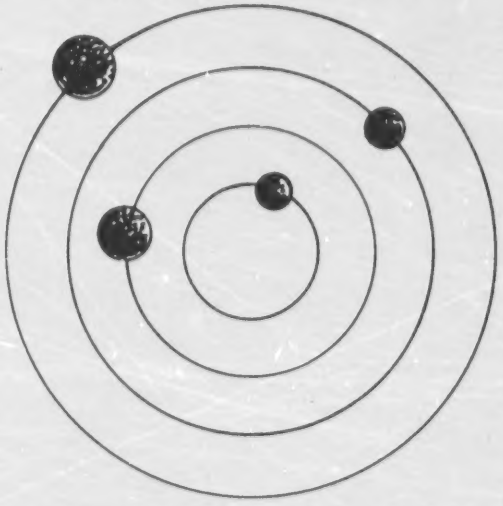


SOLAR SYSTEMS

(EARTH = 1", JUPITER = 11" ETC.)

DISTANCES

(2" = 93 MILLION MILES)



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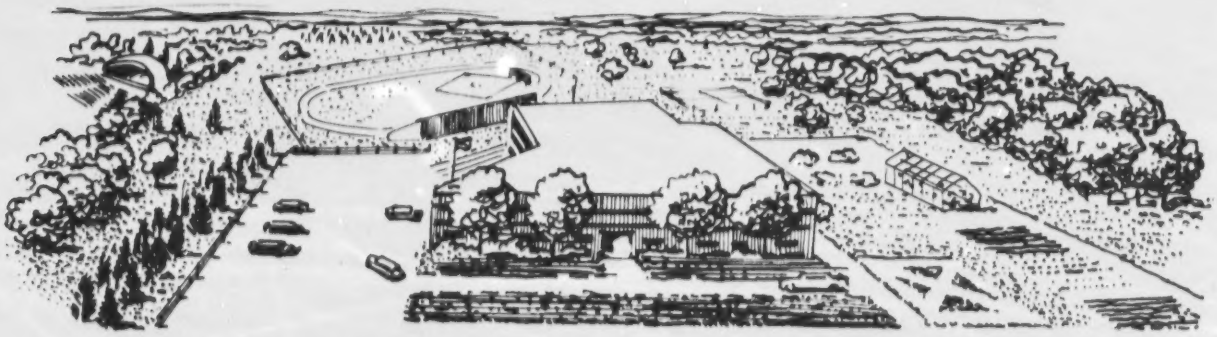
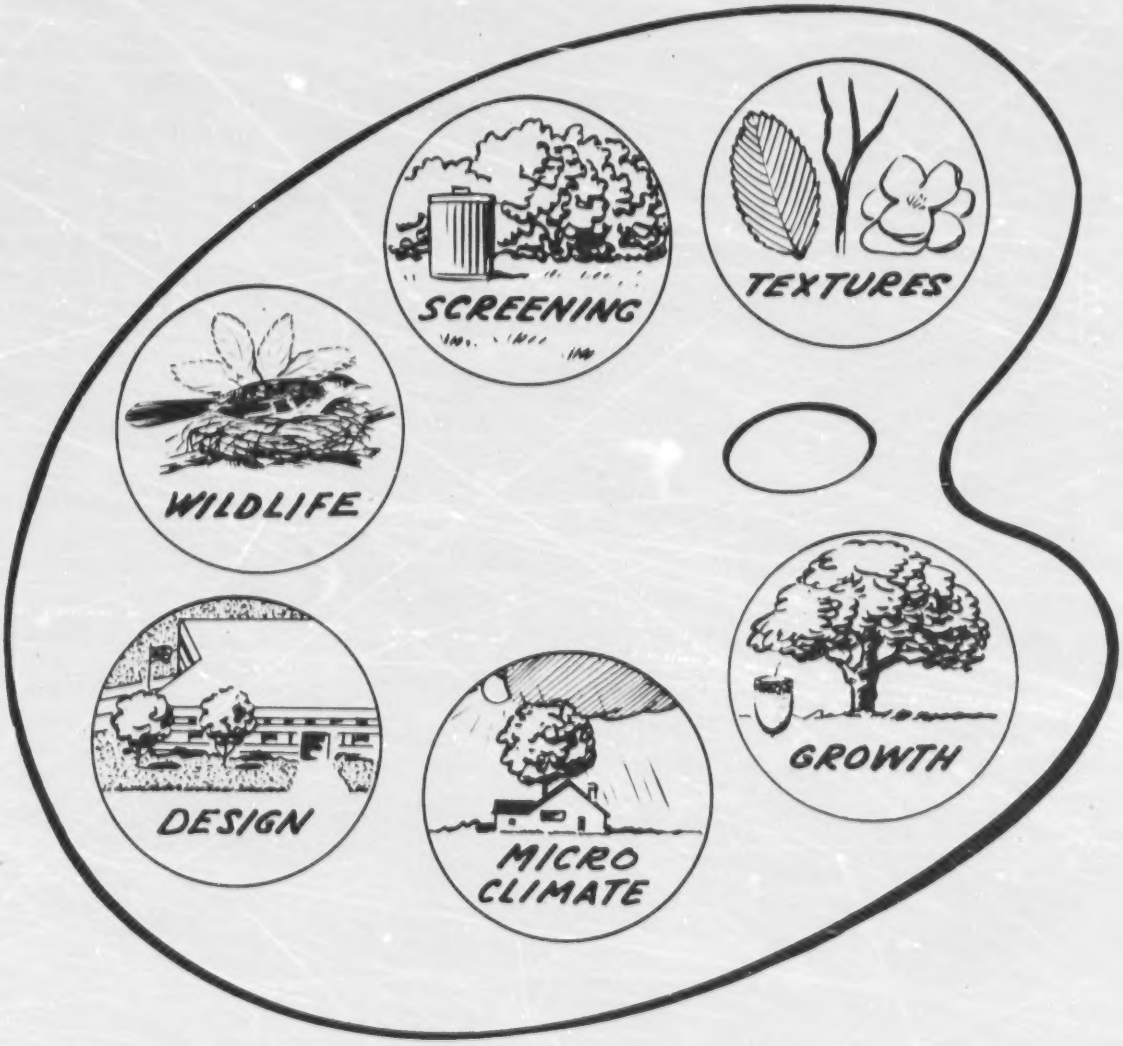
SCIENCE AND MATHEMATICS TEXTS

LANDSCAPING



CAN BE DONE ON A MULTIPLE USE BASIS



LANDSCAPE FEATURES TO FIT YOUR TEACHING CURRICULUM

IN THE

1. STUDY OF COLOR AND TEXTURES
   FLOWERS, FOLIAGE, BARK, TWIGS, DURING THE FOUR SEASONS. WINTER AND SUMMER FORM AND DESIGN PROVIDE CONTRASTS.

IN MAINTAINING

2. WILDLIFE COVER AND FOOD
   LANDSCAPING IS NOT JUST THE FOUNDATION PLANTINGS. IT WILL INCLUDE NESTING SITES, FOOD SUPPLY, ESCAPE ROUTES, NESTING AREAS, SCRATCHING AREAS, FOR WILDLIFE.

FOR

3. BEAUTIFICATION
   CAN IT MAKE US MORE CIVIC MINDED AND AWARE OF COMMUNITY AND HOME CLEAN-UP PROJECTS?

FOR

4. MICRO-CLIMATE EFFECT
   EFFECTS OF WIND, TEMPERATURES, SHADE, GLARE, RETENTION OF RAINFALL, ETC.

LABOR AND COST OF MAINTENANCE

WHAT DOES GROUNDS WORK COST - - PLANTING, MOWING, PRUNING ETC? ARE THESE COSTS OFFSET BY OTHER VALUES SUCH AS TEACHING TOOLS, AESTHETIC VALUES, EFFECTS OF MICRO-CLIMATE, ETC.

YOU CAN IMPLEMENT THESE CONCEPTS IN: MATHEMATICS, SCIENCE, SOCIAL STUDIES, VOCATIONAL TRAINING, AND ART.

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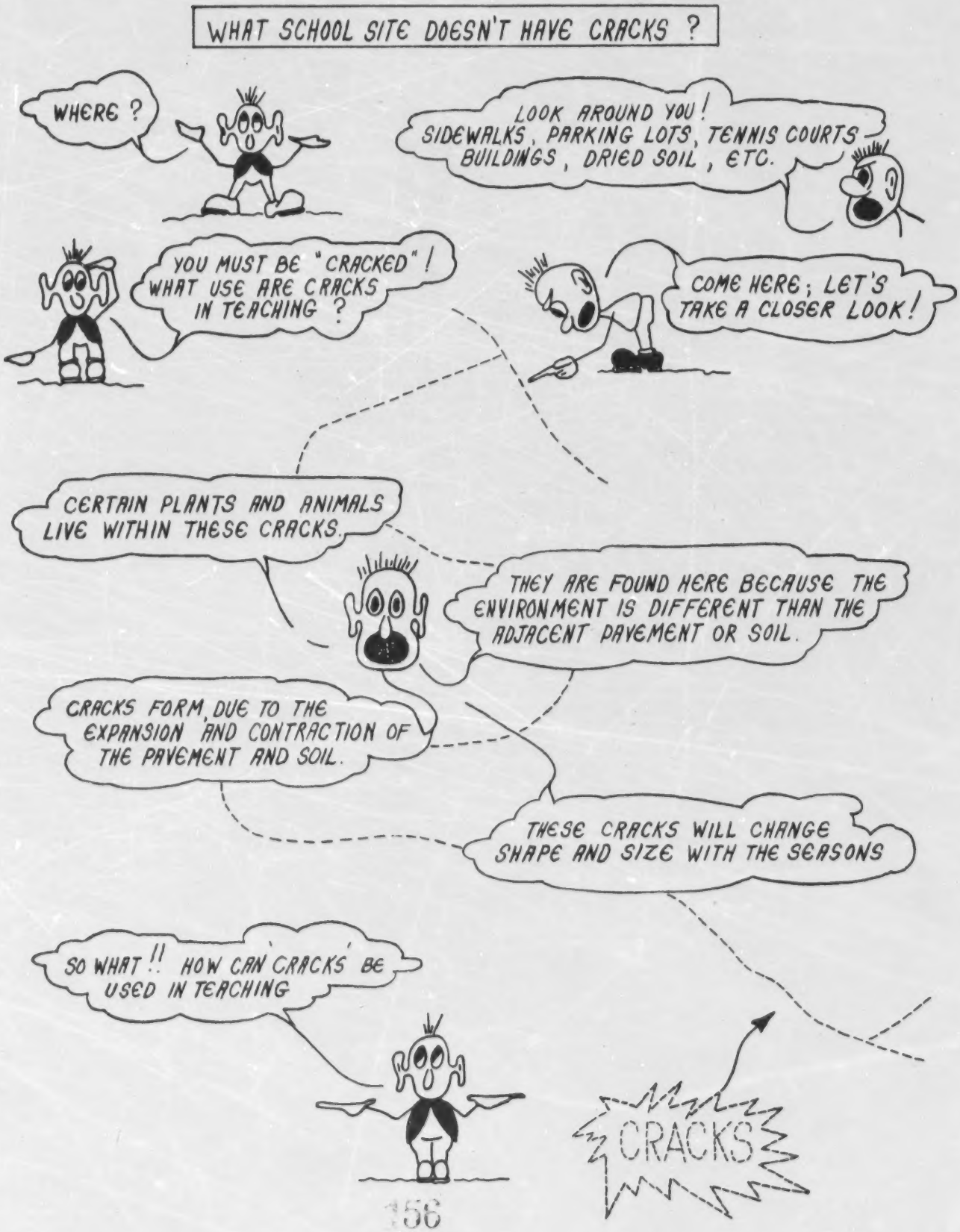
WHAT SCHOOL SITE DOESN'T HAVE CRACKS ?
WHERE ?
LOOK AROUND YOU ! SIDEWALKS , PARKING LOTS, TENNIS COURTS BUILDINGS , DRIED SOIL , ETC.
YOU MUST BE "CRACKED" ! WHAT USE ARE CRACKS IN TEACHING ?
COME HERE ; LET'S TAKE A CLOSER LOOK !
CERTAIN PLANTS AND ANIMALS LIVE WITHIN THESE CRACKS.
THEY ARE FOUND HERE BECAUSE THE ENVIRONMENT IS DIFFERENT THAN THE ADJACENT PAVEMENT OR SOIL.
CRACKS FORM DUE TO THE EXPANSION AND CONTRACTION OF THE PAVEMENT AND SOIL.
THESE CRACKS WILL CHANGE SHAPE AND SIZE WITH THE SEASONS
SO WHAT !! HOW CAN CRACKS BE USED IN TEACHING
CRACKS

MATH

MEASURE CHANGES IN CRACK WIDTH AND DEPTH OVER A PERIOD OF TIME

OBSERVE GEOMETRIC PATTERNS MADE BY CRACKS

CALCULATE AREAS PRODUCED BY CRACKS

ART

PATTERNS IN CRACK DEVELOPMENT

SOCIAL STUDIES

CRACKS IN BUILDINGS AND PAVEMENTS HAVE AN ECONOMIC EFFECT ON PEOPLE

SCIENCE

SAMPLE PLANT AND ANIMAL LIFE LIVING WITHIN CRACKS. COMPARE IN TERMS OF TYPES AND NEEDS OF ORGANISMS THAT INHABIT ADJACENT AREAS

DETERMINE THE ENVIRONMENT OF CRACKS WITH REGARD TO TEMPERATURE, LIGHT INTENSITY AND MOISTURE CONTENT.

STUDY THE SEQUENCE OF SOIL DEVELOPMENT AS RELATED TO CRACKS IN ROCKS AND PAVEMENTS

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WILDLIFE HABITAT

ALL WILDLIFE DEPENDS ON FOOD, WATER, AND SHELTER FOR SURVIVAL

FOOD	WATER	SHELTER
WILD FRUITS	WATERSHED LAKES	WINDBREAKS
WEED SEEDS	DRAINAGE DITCHES	HEDGES
NUTS, GRAINS	PONDS	FENCE ROWS
OTHER ANIMALS	STREAMS	BRUSH PILES
GREEN PLANTS	SPRINGS	HOLLOW TREES

WILDLIFE HABITAT IS PERMANENT, INEXPENSIVE, AND IT CAN BE A PART OF ANY SCHOOL SITE DEVELOPMENT

SUGGESTED ACTIVITIES

COMMUNITY GROUPS

BOY SCOUTS, GIRL SCOUTS, 4-H, AUDUBON, ETC.

A - ANIMAL TRACKS
B - STALKING OF ANIMALS
C - MAPPING WILDLIFE HABITAT
D - SPECIES COUNT

MATHEMATICS

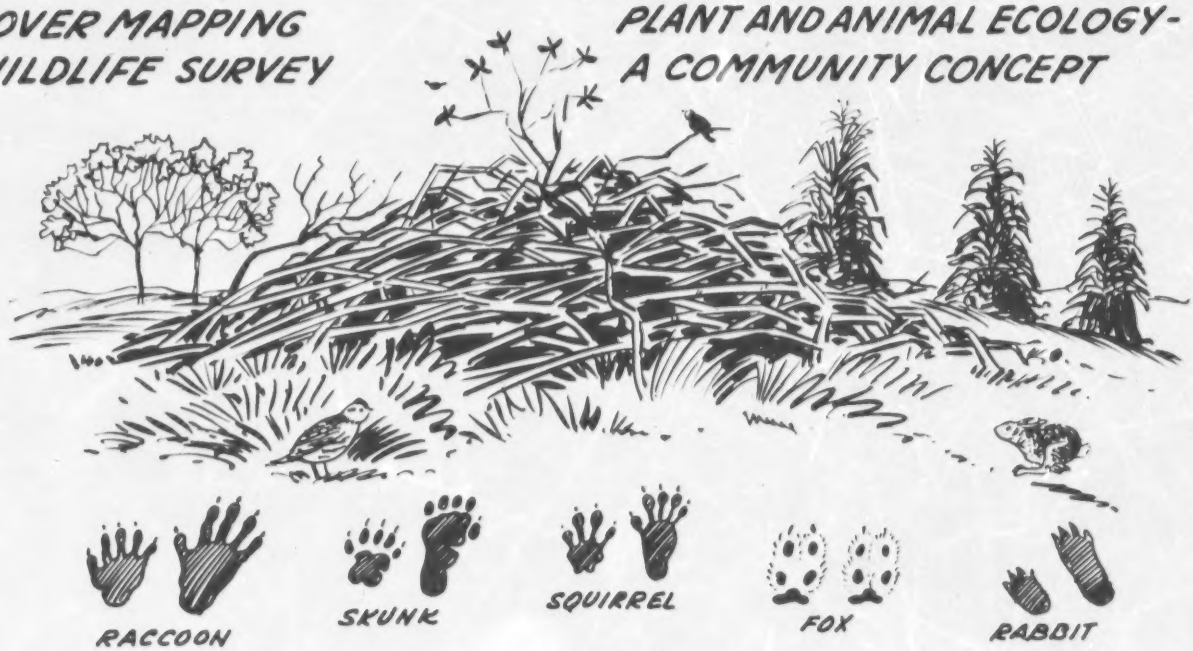
COVER MAPPING
WILDLIFE SURVEY

SCIENCE

- SOIL AND PLANT GROWTH
- PLANT & ANIMAL IDENTIFICATION
- SEED COLLECTIONS - FOOD
- LIFE HISTORIES AND CYCLES OF ANIMALS

SOCIAL STUDIES

NATURAL RESOURCE MANAGEMENT
PLANT AND ANIMAL ECOLOGY - A COMMUNITY CONCEPT



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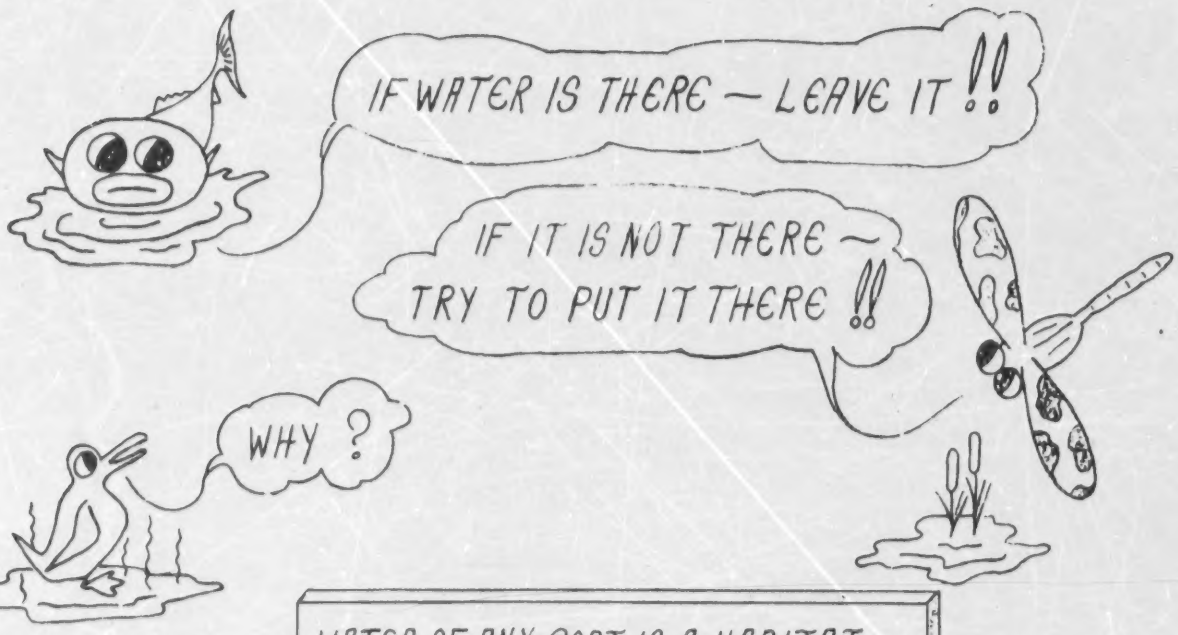
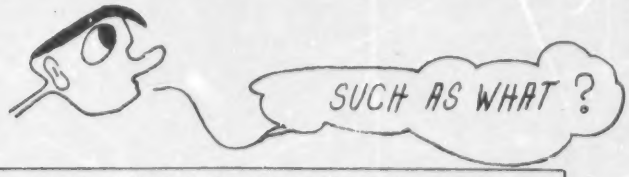
3. AN OUTLINE FOR TEACHING CONSERVATION IN ELEMENTARY SCHOOLS
4. MORE WILDLIFE THROUGH SOIL AND WATER CONSERVATION

• 3 & 4 OBTAINED FROM LOCAL OFFICE OF U.S. SOIL CONSERVATION SERVICE

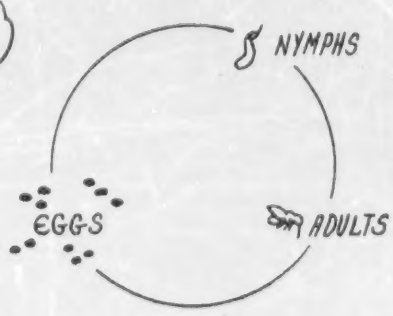


WATER OF ANY SORT IS A HABITAT OF SPECIAL CHARACTERISTICS, BE IT RIVER, POND, LAKE, PUDDLE OR SPRING. THIS HABITAT AND ITS ENVIRONMENTAL FACTORS OFFER A GREAT DEPTH OF LEARNING OPPORTUNITIES

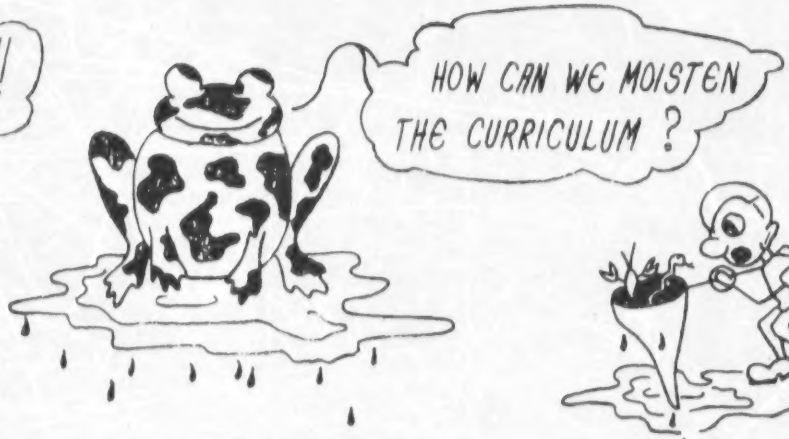


SUCH AS THE LIFE CYCLES OF CERTAIN INSECTS

AND



- STUDIES OF AQUATIC PLANTS AND ANIMALS
- AQUATIC SUCCESSION
- FACTORY FOR PRODUCTION OF AQUATIC ORGANISMS
- WATERSHED UNDERSTANDINGS
- WATER CYCLE FACTORS
- ECONOMICS OF LAND USE

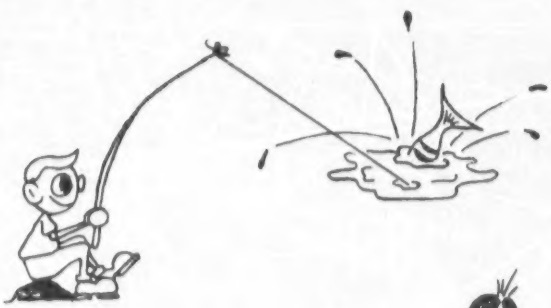


ART

1. DESIGN
2. THE NATURAL LOOK
3. SHADES AND TONES
4. COLOR

MATH

1. DENSITY CALCULATIONS
2. FLOTATION STATISTICS
3. VOLUME AND CAPACITY
4. SAMPLING



SCIENCE

1. WATER SUCCESSION OF PLANTS AND ANIMALS
2. PLANKTON FACTORY AND STUDY
3. FOOD CHAINS
4. PHYSICAL AND CHEMICAL ANALYSIS OF WATER

SOCIAL STUDIES

1. WATER SUPPLY
2. WATERSHED MANAGEMENT
3. RECREATIONAL VALUE
4. WATER CYCLE AND MAN

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HUMPHREYS, CLIFF, WATER IDEAS FOR BUSY TEACHERS,
WELLS HALL, UNIT E, MICHIGAN STATE UNIVERSITY, EAST LANSING, MICH.

CHRISTMAS TREE PLANTINGS

MOST SCHOOLS CAN DEVELOP A SMALL TREE FARM. IT CAN BE PLANTED, MANAGED, AND HARVESTED BY STUDENTS AS PART OF THEIR CLASSROOM INSTRUCTION.

DETERMINING BEST LAND USE

ADAPTING SPECIES TO SLOPE, CLIMATE, MOISTURE AND SOIL TYPE.

WHAT SPACING DO WE NEED?

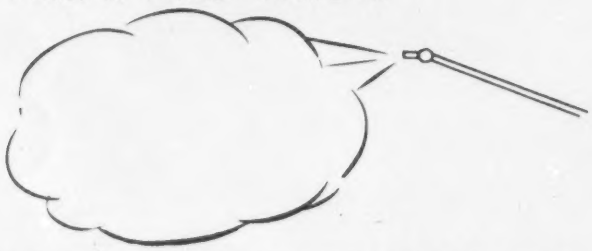
HOW MANY IN A GIVEN AREA?

WHAT SHAPE IS MOST ATTRACTIVE?

WHAT ANGLE?

HOW DOES IT FIT INTO OUR HOME OR SCHOOL ROOM?
WHAT NATURAL SHAPES DO CERTAIN VARIETIES HAVE AND TO WHAT EXTENT DO WE HAVE TO SHAPE THE TREE?

WHAT CHEMICALS CONTROL WHAT AND WHEN?



RECORDS	LABOR 10 HRS.
200 TREES @ $16/1000	$3.20
PLANTING	1965
HARVEST	- 1971
SPRAY MATERIALS	$2.46

BOOKKEEPING POSSIBILITIES

MANAGEMENT-ECONOMICS

PLANTING TIME

	APRIL	MAY	JULY
SPRAYING TIME →	1 to 17	1 to 12	16 to 25
PRUNING TIME →			
HARVESTING TIME →			

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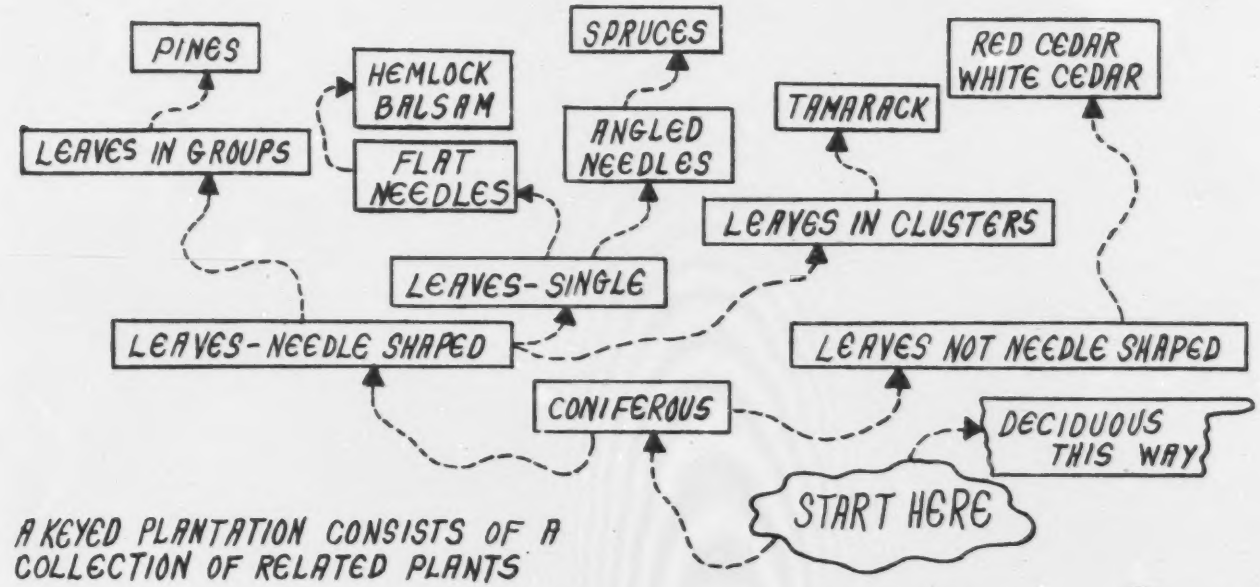
1-SELECTING SPECIES OF CHRISTMAS TREES FOR PLANTING IN MICHIGAN
2-CHRISTMAS TREE INSECT CONTROL. 3-SHEARING AND SHAPING CHRISTMAS TREES.
M.S.U. COOP EXTENSION SERVICE, EAST LANSING, MICHIGAN, FOR ALL THREE.

KEYED PLANTATIONS



A KEYED PLANTATION CONSISTS OF A COLLECTION OF RELATED PLANTS

THE SPECIMENS ARE PLANTED IN SUCH POSITIONS THAT WHEN APPROACHED FROM THE RIGHT ENTRY THEY PRESENT TO THE VIEWER A SUCCESSION OF COMPARISONS.

"HERE IS A REAL KEY TO LEARNING"

THE CONCEPT OF KEYING IS MADE MEANINGFUL THROUGH DIRECT EXPERIENCE AND APPLICATION.

HABITAT CAN BE VARIED TO FIT THE SPECIFIC REQUIREMENTS OF THE SPECIMENS USED.

HABITATS CAN BE CLASSIFIED RIGHT ALONG WITH THE PLANT SPECIMENS.

PLANTS HAVE SCIENTIFIC NAMES WHICH ARE UNDERSTOOD UNIVERSALLY BY LEARNED PEOPLE

LOOK AT THE DOORS THAT A KEY CAN OPEN IN OUR CURRICULUM

SCIENCE

1. KEYING - TAXONOMY OF PLANT LIFE
2. ECOLOGY - INTERRELATIONSHIPS IN NATURE
3. TAXONOMY OF HABITATS

MATH

1. SURVEYING AND MAPPING
2. ARITHMETIC AND GEOMETRIC PROGRESSIONS
3. CUMULATIVE GROWTH DATA

ART

1. DESIGN ~ TREE SHAPES, LEAF SHAPE
2. ESTHETIC APPRECIATION FOR NATURE
3. FALL COLORING - WATER COLORS
4. SEASONAL SCENES

SOCIAL STUDIES

1. WOOD INDUSTRIES OF MICHIGAN
2. NATURAL RESOURCE MANAGEMENT (TIMBER)

YOUR LOCAL NATURE CLUB CAN BE A REAL HELP IN DEVELOPING, MAINTAINING AND USING A KEYED PLANTATION

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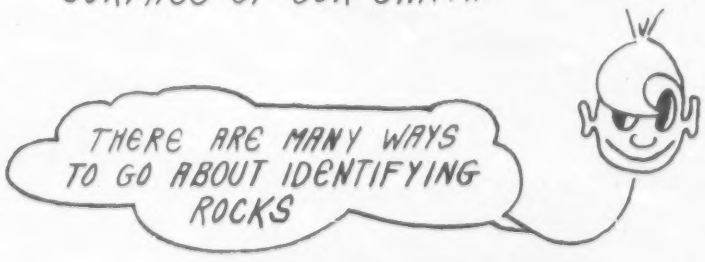
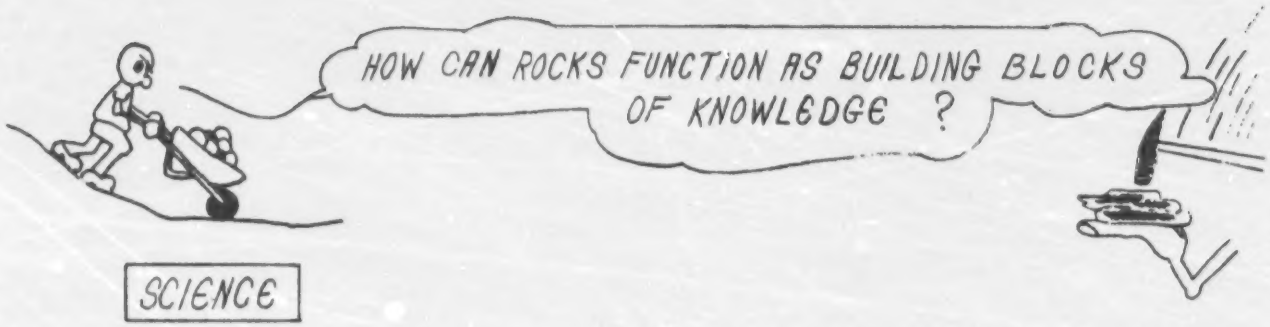
HEY!! THIS IS MARBLE
ESTABLISH A BOULDER FIELD
IGNEOUS ROCKS
SEDIMENTARY ROCKS
METAMORPHIC ROCKS
GLACIAL DRIFT
WHAT'S IN A ROCKPILE ?
TAKE ANY OF THE 4 PATHS AND FIND OUT !!
ACTUALLY, WE ROCKS DO A LOT OF TALKING

" WE TELL SOMETHING ABOUT THE GEOLOGIC HISTORY OF THE SURFACE OF OUR EARTH "

SUCH AS :

1. GLACIAL ACTIVITY
2. MOUNTAIN BUILDING
3. MINERAL RESOURCES
4. LAKES AND OCEANS
5. LIFE OF THE PAST
6. EARTH MOVEMENTS





SCIENCE

1. ROCK IDENTIFICATION
2. MINERAL IDENTIFICATION
3. CRYSTALIZATION
4. ROCK AND MINERAL RELATIONSHIP TO SOIL
5. ROCK FORMATION [HEAT-WATER-PRESSURE]

MATH

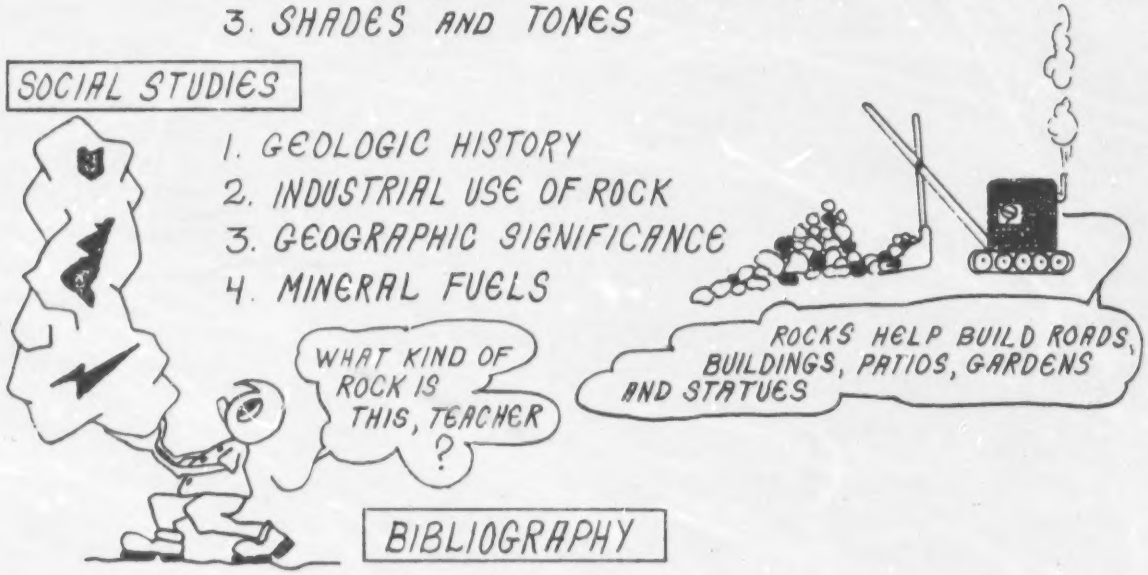
1. DENSITY - (A GOOD TOOL TO HELP IDENTIFY ROCKS)
2. RATIO AND PROPORTION - (MINERALS TO ROCKS)

ART

1. COLOR - (MINERALS GIVE ROCKS PECULIAR COLORS)
2. DESIGN - (CRYSTALS CREATE A VARIETY OF DESIGNS)
3. SHADES AND TONES

SOCIAL STUDIES

1. GEOLOGIC HISTORY
2. INDUSTRIAL USE OF ROCK
3. GEOGRAPHIC SIGNIFICANCE
4. MINERAL FUELS



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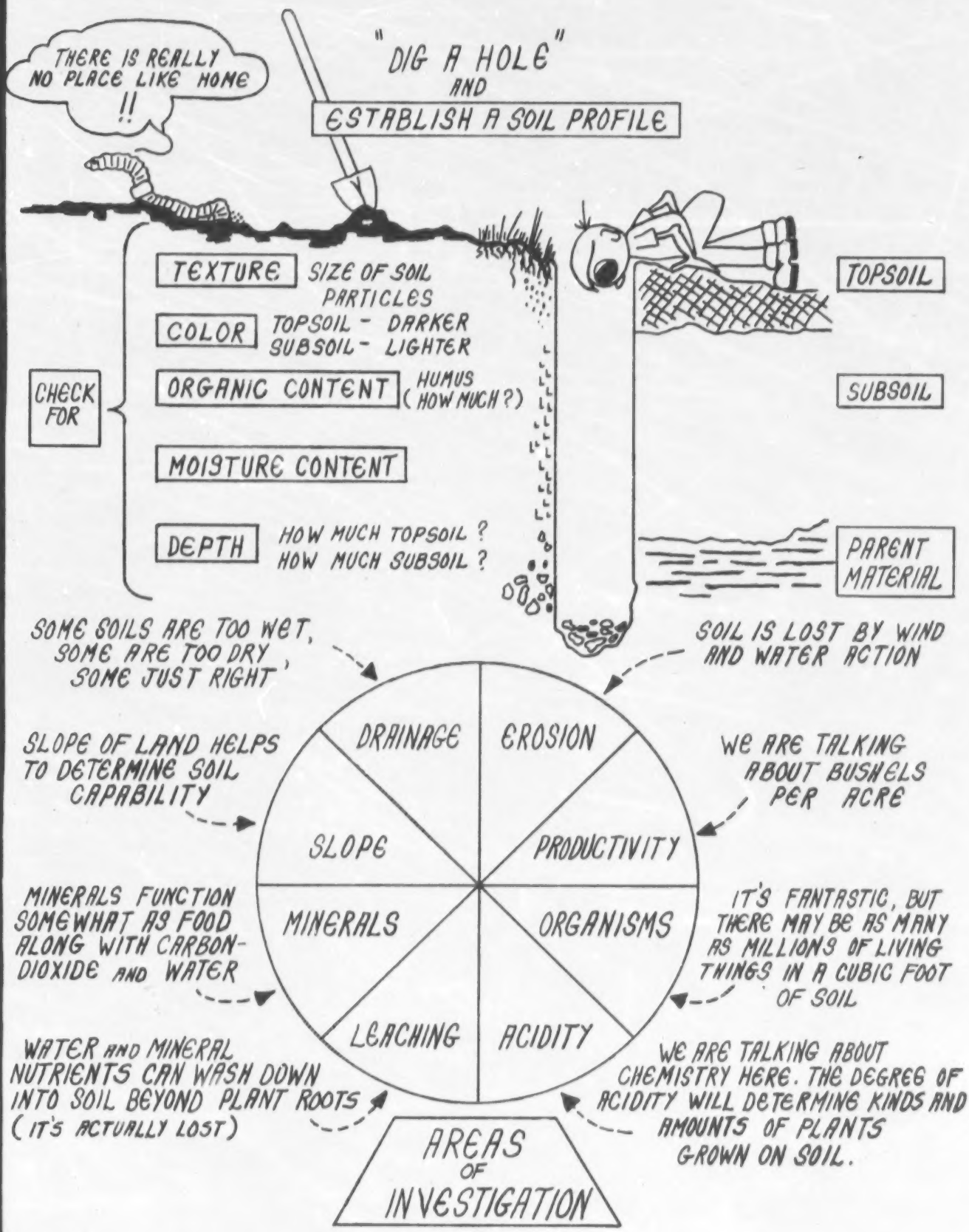
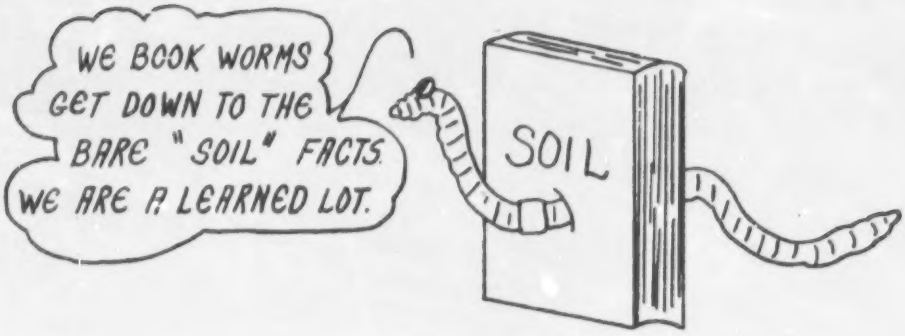

THERE IS REALLY NO PLACE LIKE HOME !!
"DIG A HOLE" AND ESTABLISH A SOIL PROFILE
TOPSOIL
SUBSOIL
PARENT MATERIAL
CHECK FOR
TEXTURE
SIZE OF SOIL PARTICLES
COLOR
TOPSOIL - DARKER
SUBSOIL - LIGHTER
ORGANIC CONTENT
HUMUS (HOW MUCH?)
MOISTURE CONTENT
DEPTH
HOW MUCH TOPSOIL ?
HOW MUCH SUBSOIL ?
SOME SOILS ARE TOO WET, SOME ARE TOO DRY, SOME JUST RIGHT
SOIL IS LOST BY WIND AND WATER ACTION
SLOPE OF LAND HELPS TO DETERMINE SOIL CAPABILITY
WE ARE TALKING ABOUT BUSHELS PER ACRE
DRAINAGE
EROSION
SLOPE
PRODUCTIVITY
MINERALS
ORGANISMS
LEACHING
ACIDITY
MINERALS FUNCTION SOMEWHAT AS FOOD ALONG WITH CARBON-DIOXIDE AND WATER
IT'S FANTASTIC, BUT THERE MAY BE AS MANY AS MILLIONS OF LIVING THINGS IN A CUBIC FOOT OF SOIL
WATER AND MINERAL NUTRIENTS CAN WASH DOWN INTO SOIL BEYOND PLANT ROOTS (IT'S ACTUALLY LOST)
WE ARE TALKING ABOUT CHEMISTRY HERE. THE DEGREE OF ACIDITY WILL DETERMINE KINDS AND AMOUNTS OF PLANTS GROWN ON SOIL.
AREAS OF INVESTIGATION



"THERE IS A LOT TO KNOW ABOUT THIS STUFF"

SCIENCE

1. PLANT GROWTH - SOIL STUDIES
2. pH ANALYSIS (TOO ACID; TOO BASIC; JUST RIGHT)
3. CHEMICAL AND PHYSICAL BREAKDOWN OF SOIL FORMING MATERIALS
4. SOIL ECOLOGY (INTERRELATIONSHIP OF SOIL TO ALL SITE FACTORS)

MATH

1. PERCENT - (PLANTS ? ANIMALS ? MINERALS ? WATER ? AIR ?)
2. RATIO AND PROPORTION
3. SAMPLING (LEADS TO HELPFUL SOIL ANALYSIS)
4. GRAPHS

SOCIAL STUDIES

1. SOIL TYPES AND ECONOMICS OF AN AREA
2. SOIL MISUSE AND POVERTY
3. LAND USE AND PROGRESS
4. ZONING

GOOD SOIL - PROSPEROUS PEOPLE

POOR SOIL - POOR PEOPLE

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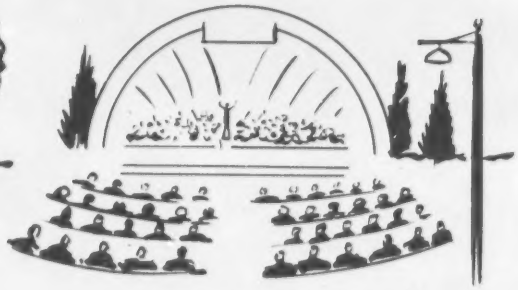
COMMUNITY AND SCHOOL USES OF NATURAL RESOURCES

WIND TO STOP

WATER TO CONTROL



MUSIC TO HEAR

GAMES TO PLAY

SPACE TO RELAX IN

TREES TO RAISE

CLEANLINESS TO LEARN

FOOD TO PREPARE

WATER LIFE TO ATTEND

TREES TO IDENTIFY

LEAVES TO IDENTIFY

BIRDS TO SEE

SLOPES TO SLIDE AND PLAY ON

ANIMALS TO FEED

YEAR-AROUND COMMUNITY USE--BEAUTY WITH PURPOSE

MANY USES - SCHOOL AND COMMUNITY

WHO

1. FAMILIES
2. INDIVIDUALS
3. ORGANIZATIONS

HOME EC. OUTDOOR MEALS

1. BALANCED MEALS
2. COOKING TECHNIQUES

NATURE STUDY

1. LEAF PRINTS
2. LEAF IDENTIFICATION
3. TREES
4. WILDFLOWERS

CONSERVATION

1. WATER
2. SOIL EROSION
3. WIND EROSION
4. WILD LIFE

ART

1. POSTERS AND SIGNS
2. PHOTOGRAPHY

SHOPWORK

1. BUILD BIRD HOUSES
2. BUILD BIRD BATHS

MUSIC ENJOYMENT

1. VOCAL
2. INSTRUMENTAL

RECREATION

1. WALKING
2. BASEBALL
3. BADMINTON
4. TENNIS
5. SHUFFLEBOARD
6. SLEDDING & SKATING
7. ICE FISHING

CITIZENSHIP 1. PRIDE IN COMMUNITY 2. NO LITTERING

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